Eder Acquisition
2007 Habitat Evaluation Procedures Report

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Abstract

A habitat evaluation procedures (HEP) analysis was conducted on the Eder acquisition in July 2007 to determine how many protection habitat units to credit Bonneville Power Administration (BPA) for providing funds to acquire the project site as partial mitigation for habitat losses associated with construction of Grand Coulee and Chief Joseph Dams. Baseline HEP surveys generated 3,857.64 habitat units or 1.16 HUs per acre.

HEP surveys also served to document general habitat conditions. Survey results indicated that the herbaceous plant community lacked forbs species, which may be due to both livestock grazing and the late timing of the surveys. Moreover, the herbaceous plant community lacked structure based on lower than expected visual obstruction readings (VOR); likely a direct result of livestock impacts. In addition, introduced herbaceous vegetation including cultivated pasture grasses, e.g. crested wheatgrass and/or invader species such as cheatgrass and mustard, were present on most areas surveyed.

The shrub element within the shrubsteppe cover type was generally a mosaic of moderate to dense shrubby areas interspersed with open grassland communities while the “steppe” component was almost entirely devoid of shrubs. Riparian shrub and forest areas were somewhat stressed by livestock. Moreover, shrub and tree communities along the lower reaches of Nine Mile Creek suffered from lack of water due to the previous landowners “piping” water out of the stream channel.

Introduction

The Washington Department of Fish and Wildlife (WDFW) purchased the 3,337 acre Eder acquisition on June 28, 2007 (D. Budd and P. Dahmer, pers. comm.) in partnership with Bonneville Power Administration as partial fulfillment of BPA’s mitigation obligation from construction of Grand Coulee Dam (Howerton et. al. 1986) and Chief Joseph Dam (Berger and Kuehn 1992). Both Memorandum of Agreement (MOA) (BPA/WDFW 1996) and Washington State Wildlife funds were used to purchase the property. MOA funds totaled $3,033,832 while State expenditures equaled $31,000 (P. Dahmer, pers. comm.). The 2007 acquisition included only the east portion of the Eder Ranch. WDFW intends to purchase the west half of the property in the near future (J. Olson, pers. comm.).

WDFW acquired the Eder Ranch primarily to protect critical winter deer range and sharp-tailed grouse (*Typanuchus phasianellus columbianus*) habitat (J. Olson, pers. comm.). A myriad of other wildlife species, however, will benefit from protection and enhancement measures.

A Habitat Evaluation Procedures (HEP) (USFWS 1980) analysis was conducted by the Columbia Basin Fish and Wildlife Authority’s (CBFWA) Regional HEP Team (RHT) in 2007 to determine the number of habitat units (HUs) to credit BPA for providing the funds to acquire the property. Details and results of the HEP analysis are described in this report.

Study Area

General Description

Location

Located in north central Washington approximately three miles northeast of Oroville, the Eder property borders Canada on the north and lies one mile east of Lake Osoyoos (Figure 1). Universal Trans Mercator (UTM) coordinates are 11U 0328200E, 5427310N.

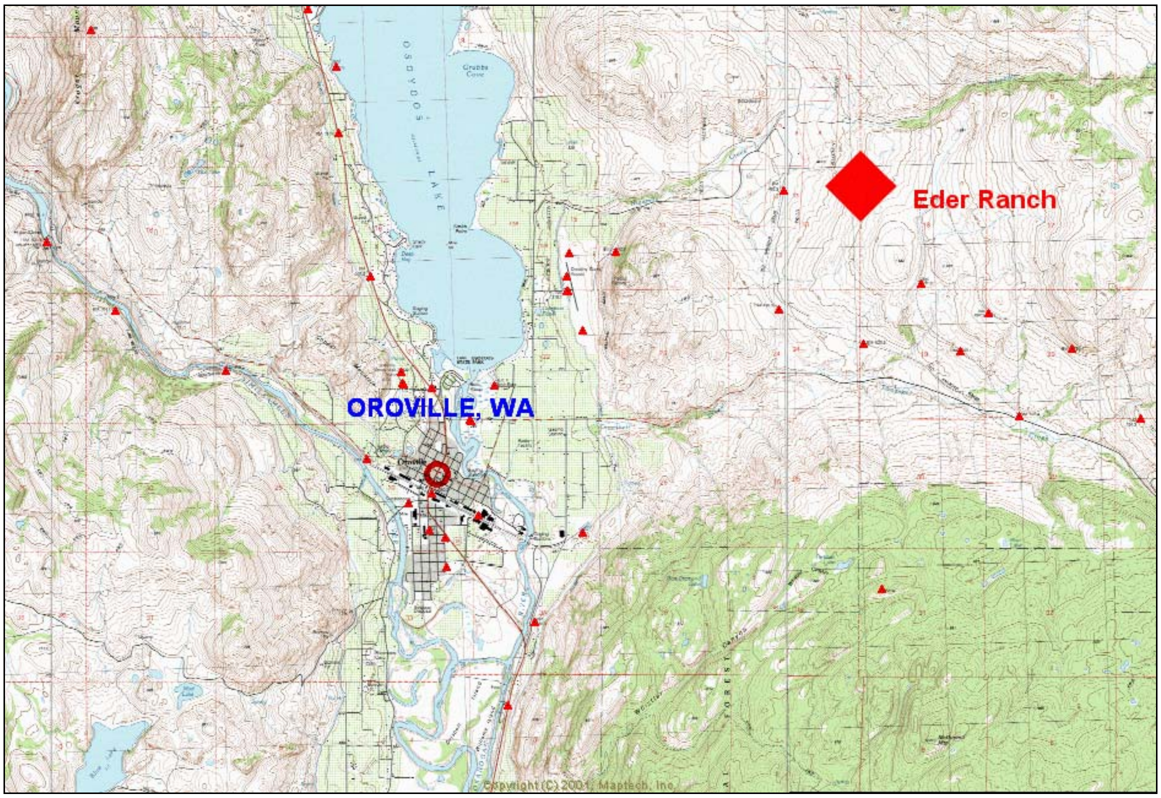

Figure 1. General location of the Eder acquisition.

Project boundaries, illustrated in Figure 2, were furnished by WDFW (J. Olson, pers. comm.) as “hard copy” maps. The boundaries were redrawn on Maptech ® mapping software by Regional HEP Team staff. As a result, map boundaries depicted in Figure 2 may be up to ± 300 feet in error except for the north boundary which is the international boundary with Canada.

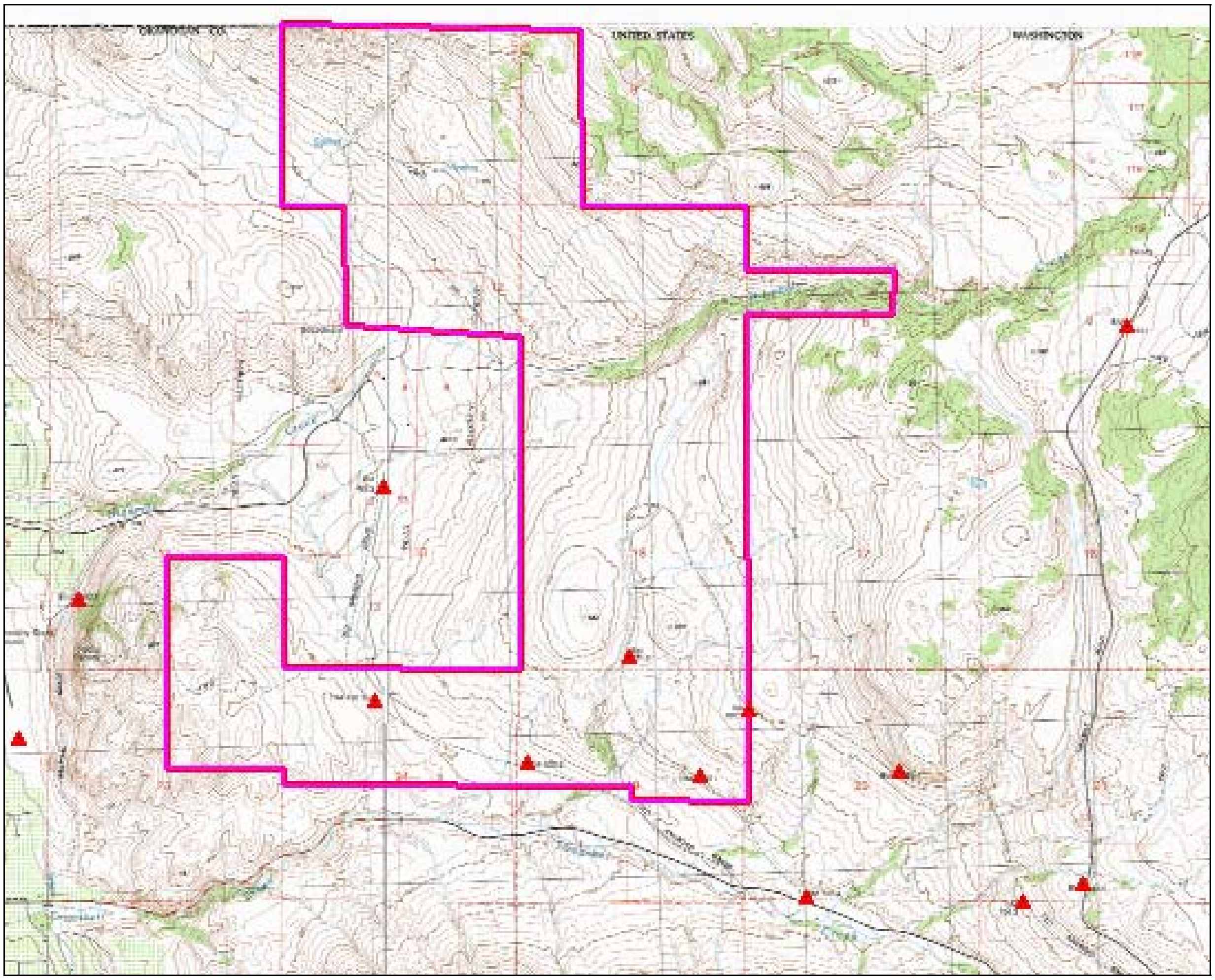

Figure 2. Eder acquisition project boundary.

Topography

Elevation ranges from approximately 1,500 feet to over 2,700 feet. Topography varies from flat pasture and rolling hills to steep stream channels and mountainous terrain dominated by rock outcrops.

Cover Types

Cover type maps were not available prior to initiation of the HEP analysis because there was insufficient time between the date of purchase and the HEP study for WDFW GIS staff to develop maps (P. Dahmer, pers. comm.). Therefore, RHT staff developed coarse cover type maps from aerial photographs and "ground-truthed" the maps while conducting HEP surveys.

Six primary cover types were delineated by Regional HEP Team staff i.e., shrubsteppe, grassland, rockland, riparian shrub, riparian forest, and conifer forest. Cover type acreages are shown in Table 1 and presented in Figure 3.

Table 1. Eder property cover types, acres, and relative percent of area.

Cover Type	Acres	Percent of Area
Shrubsteppe	2,346	70
Grassland	749	22
Rockland	135	4
Riparian Shrub	23	<1
Riparian Forest	66	2
Conifer Forest	18	<1
Total	**3,337**	**≈100**

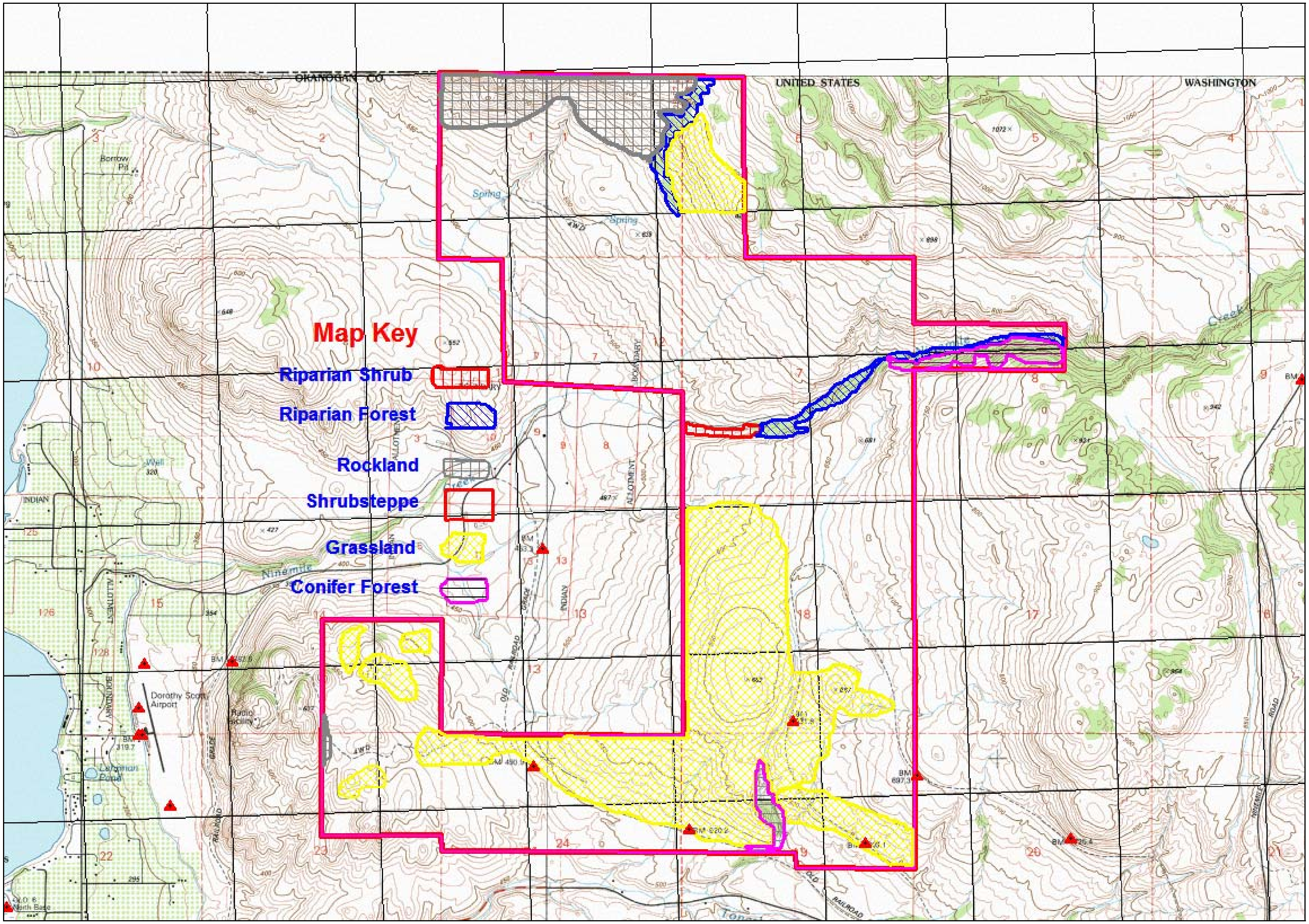

Figure 3. Eder property coarse filter cover type map.

Cover Type Descriptions

Xeric uplands dominate the landscape with shrubsteppe comprising approximately 70% of the area. Grasslands cover 22% while rockland, riparian shrub, riparian forest and conifer forest combined equal less than 8% of the project site. Rockland is found primarily along the north boundary with Canada. Riparian cover types occur either in conjunction with spring sites, or along Nine Mile Creek (Figure 3).

Shrubsteppe

The shrubsteppe cover type is comprised of xeric uplands with ≥ 5% shrub cover and ≤ 5% tree canopy. Although not typically observed all on the same transect, shrub species included big sagebrush (*Artemisia tridentata*), three-tip sagebrush (*A. tripartite*), bitterbrush (*Purshia tridentata*), green rabbitbrush (*Chrysothamnus viscidiflorus*), and currant (*Ribes* spp.). Shrubs were either dispersed relatively uniformly or as mosaics where shrubs were "clumped", interspersed with small openings dominated by herbaceous vegetation.

The herbaceous layer was comprised of both native and introduced species e.g., bluebunch wheatgrass (*Pseudoroegneria spicata*) and cheatgrass (*Bromus tectorum*) respectively. An example of shrubsteppe habitat is shown in Figure 4.

Figure 4. An example of the shrubsteppe cover type.

Grassland

Grasslands generally occurred on upland sites and supported < 5% shrub and/or tree cover. Herbaceous cover was dominated by native and introduced grass species (few forbs were present most likely due to a combination of livestock grazing and the late timing of the surveys i.e., most forbs are desiccated by late July). Common native grass species observed were bluebunch wheatgrass, Sandberg bluegrass (*Poa sandbergii*), needle-and-thread (*Stipa comata*), and sand dropseed (*Sporobolus cryptandrus*).

Non-native herbaceous species included introduced pasture grasses, cheatgrass, and mustard (*Sisymbrium* spp.) to name a few. Transect results indicated that percent cover of exotic herbaceous species ranged from <5% to more than 80%. The grassland cover type is illustrated in Figure 5.

Figure 5. An example of the grassland cover type.

Rockland

The rockland cover type is characterized by boulders and cliffs interspersed with shrubs and/or trees. A herbaceous layer occurs where soils are present. Shrub cover is dominated by big sagebrush while ponderosa pine (*Pinus ponderosa*) trees are scattered throughout the cover type (Figure 6).

Figure 6. An example of the rockland cover type.

Riparian Shrub

Both hydrophytic and upland shrub species were present within the complex riparian shrub cover type. Shrub species varied by specific location, but all survey sites included rose (*Rosa* spp.) and snowberry (*Symphoricarpus albus*). Other shrubs[1] observed were hawthorn (*Crataegus douglassi*), black cottonwood (*Populus trichocarpa*), mock orange (*Philadelphus lewisii*), chokecherry (*Prunus virginiana*), and clematis (*Clematis ligusticifolia*). In contrast, introduced Russian olive (*Elaeagnus angustifolia*) shrubs completely dominated one transect located in a mesic pasture (Transect 44). An example of the riparian shrub cover type is shown in Figure 7.

[1] All woody stemmed plants less than 16 feet in height were considered to function as shrubs regardless of species.

Figure 7. An example of riparian shrub understory.

Riparian Forest

Both hydrophytic and upland tree and shrub species were detected in the riparian forest cover type. Tree species included water birch (*Betula occidentalis*), aspen (*Populus tremuloides*), willow (*Salix* spp.), ponderosa pine, Douglas fir (*Pseudotsuga menziesii*), maple (*Acer glabrum*), black cottonwood, and alder (*Alnus* spp.). Tree species varied by transect with tree canopy cover ranging from 10% to 70%.

Riparian forest shrub understory was similar to that described for the riparian shrub cover type. Understory shrub species included dogwood (*Cornus stolonifera*), aspen, rose, snowberry, maple, water birch, willow, mock orange, clematis, and serviceberry (*Amelanchier alnifolia*). The riparian forest cover type is illustrated in Figure 8.

Figure 8. Riparian forest cover type photo.

Conifer Forest

The conifer forest cover type is dominated by ponderosa pine followed by Douglas fir trees. Shrubs may include sagebrush, bitterbrush, rose, snowberry, maple, mock orange, clematis, and serviceberry. This cover type was included with riparian forest in the HEP assessment because the same HEP evaluation species was applied to both cover types. No photograph is available for this cover type.

Methods

Habitat Evaluation Procedures

A habitat evaluation procedures analysis was conducted on the Eder acquisition to document baseline habitat conditions and to determine how many protection habitat units to credit BPA for providing funds to acquire the project site as partial mitigation for habitat losses associated with construction of Grand Coulee and Chief Joseph Dams. HEP, developed by the U.S. Fish and Wildlife Service (USFWS), is used to quantify the impacts of development, protection, and restoration projects/measures on terrestrial and aquatic habitats by assessing changes, both negative and positive, in habitat quality and quantity (USFWS 1980), (USFWS 1980a).

HEP is a habitat based approach to impact assessment that documents change through use of a habitat suitability index (HSI). The HSI value is derived from an evaluation of the ability of key habitat components to provide the life requisites of selected wildlife and fish species.

The HSI value is an index to habitat carrying capacity for a specific species or guild of species based on a performance measure (e.g. number of deer per square mile) described in HEP species models. The index ranges from 0.0 to 1.0. A HSI of 0.3 indicates that habitat quality/carrying capacity is marginal while a HSI of 0.7 suggests that habitat quality/carrying capacity is relatively good for a particular species (Table 2).

Table 2. Habitat suitability index verbal equivalency table.

Habitat Suitability Index	Verbal Equivalent
0.0 < 0.2	Poor
0.2 < 0.4	Marginal
0.4 < 0.6	Fair
0.6 < 0.9	Good
0.9 < 1.0	Optimum

Each increment of change is identical. For example, a change in HSI from 0.1 to 0.2 represents the same magnitude of change as a change from 0.2 to 0.3, and so forth. Habitat variables, suggested mensuration techniques, and mathematical aggregations of assessment results are included in HEP evaluation species models.

Habitat units are determined by multiplying the habitat suitability index by the number of acres of habitat (cover type) protected. For example, if the HSI output for a mule deer HEP model is 0.5 and the number of acres of shrubsteppe habitat protected is 100, then the number of HUs are 50 (0.5 HSI x 100 acres = 50 HUs).

HEP Model Selection

HEP model selection was based on habitat types and species models identified in the Grand Coulee Dam (Howerton et al. 1986) and Chief Joseph Dam (Berger and Kuehn 1992) Loss Assessments. At Grand Coulee Dam, Howerton et al. (1986) did not clearly assign HEP species models to specific cover types making it difficult to develop a concise species/cover type matrix[2]. In addition, contrary to HEP protocols two "cover type" HEP models[3] (riparian shrub and riparian forest) were also included in the loss assessment.

Specific HEP models were not included in the Grand Coulee Dam Loss Assessment (Howerton et al. 1986) and were unavailable for the Eder HEP assessment. Therefore, models from other sources were used to evaluate the Eder wildlife mitigation site. In contrast, Berger and Kuehn (1992) included the bobcat HSI model in the Chief Joseph Dam Loss Assessment, which was used to evaluate the rockland cover type on the Eder parcel.

[2] The Coulee Dam species/cover type matrix is a draft document and subject to debate. It is, however, based on the best available data.
[3] By definition, cover types cannot be HEP models because HEP models must include a wildlife species.

Consistent with other WDFW mitigation projects, HEP models selected by the Regional HEP Team to assess baseline habitat conditions included mule deer (*Odocoileus hemionus*) (Ashley and Berger 1996), western meadowlark (*Sturnella neglecta*) (Schroeder and Sousa 1982), sharp-tailed grouse, (*Tympanuchus phasianellus*) (Ashley 2003), Bobcat (*Lynx rufus*) (Bodurtha 1991) and Downy Woodpecker (*Picoides pubescens*) (Schroeder 1982). Abbreviated HEP models are included in Appendix A.

The 2007 Eder HEP evaluation cover type/species matrix shown in Table 3 is based primarily on information from the Grand Coulee Dam loss assessment (Howerton et al. 1986). The matrix also includes the rockland cover type and bobcat HSI model identified in the Chief Joseph Dam loss assessment (Berger and Kuehn 1992). *As a result, bobcat habitat units were credited against Chief Joseph Dam while all other HU gains were credited against losses at Grand Coulee Dam.*

Table 3. Eder project 2007 HEP loss assessment matrix.

Eder 2007 HEP MODEL/COVER TYPE MATRIX							
HEP MODEL	COVER TYPES						
	Shrubsteppe	Grassland	Rockland	Riparian Shrub	Riparian - Conifer Forest	Coulee Dam	Chief Joseph Dam
Mule deer	x	x				x	
Western meadowlark	x	x				x	
Sharp-tailed grouse	x	x		x		x	
Bobcat			x				x
Downy Woodpecker					x	x	
TOTAL	3	3	1	1	1	4	2

HEP Species Model Selection Rationale

Species selection rationale described in the Grand Coulee Dam Loss Assessment (Howerton et al. 1986) and from the Chief Joseph loss assessment (Berger and Kuehn 1992) is summarized in Table 4.

Table 4. HEP model species selection rationale table.

HEP Model	Rationale
Mule deer	This species represents wildlife dependent upon shrubsteppe and river breaks.
Western meadowlark	Represents wildlife species dependent upon grassland and/or shrubsteppe habitats.
Sharp-tailed grouse	Represents wildlife species dependent upon grasslands/shrubsteppe habitat (includes riparian draws and limited agriculture).
Bobcat	Represents wildlife species dependent upon rocky areas and adjacent grassland/shrubsteppe habitat.
Downy Woodpecker	The species represents wildlife dependent upon riparian forest habitats and snags.

Sampling Design and Measurement Protocols

Meta Data

Level one meta data follows that suggested by Gotelli and Ellison (2004). Field surveys were conducted by the Columbia Basin Fish and Wildlife Authority Regional HEP Team with assistance from WDFW Wildlife Area staff Jim Olson and Bryan Dupont. Regional HEP Team members included Paul Ashley (RHT Coordinator), Mike Cantonese (Team Leader), Anthony Muse, Paul Walker, and Tiffany Baker (contact Paul Ashley @ lonepinebutte@comcast.net, or through CBFWA at: [503] 229-0191).

Funding for the HEP analyses was provided by the Bonneville Power Administration with RHT administrative support provided by CBFWA. Specific measurement techniques and protocols are described in detail in Appendix B. Measurements were recorded in standard U.S. units except for the Robel pole (Robel et al. 1975), which was recorded in metric units.

Transect Methods

In most cases, the Regional HEP team used measurement techniques and protocols described in HEP models to evaluate habitat variables; however, ocular estimations were used when direct measurements could not be taken. Measured techniques were occasionally modified to meet unique habitat and/or physiographic conditions. Metrics generally followed those described by Hays et al. (1981) and/or Avery (1994).

Stratified (by cover type), random transects were established and documented using global positioning system (GPS) coordinates and, in many cases, rebar stakes. Ashley (2006) described the methods and protocols used by Regional HEP Team staff to collect HEP model variable data and additional floristic information (Appendix B). Field data was summarized and applied to HEP model variables to determine habitat suitability indices and habitat units for each HEP species model. Field data collection and processing procedures are illustrated in Figure 9 and summarized as follows.

HEP model variable field data was entered onto Allegro CE® data logger spreadsheets (1), or recorded on paper data sheets (2). The raw field data (3) was downloaded from the data loggers or manually entered from paper data sheets onto computers (transect photos were also downloaded and stored on field computers). The raw data and photos were compiled for each transect into three basic products/files (4) <u>that are provided to project managers</u> as report appendices and/or separate CD files.

Product files included raw field data downloaded from the data loggers (5), data summary spreadsheets (6) which are the results of compiling/processing the raw data, and transect photo files (7). Summarized/processed data from each transect was applied to appropriate HEP model variables to determine suitability index (SI) ratings that were combined on habitat suitability index (HSI) spreadsheets (8) to determine the HSI for a particular HEP species model/cover type. The habitat suitability index was then multiplied by the number of cover type acres to determine the number of habitat units (9).

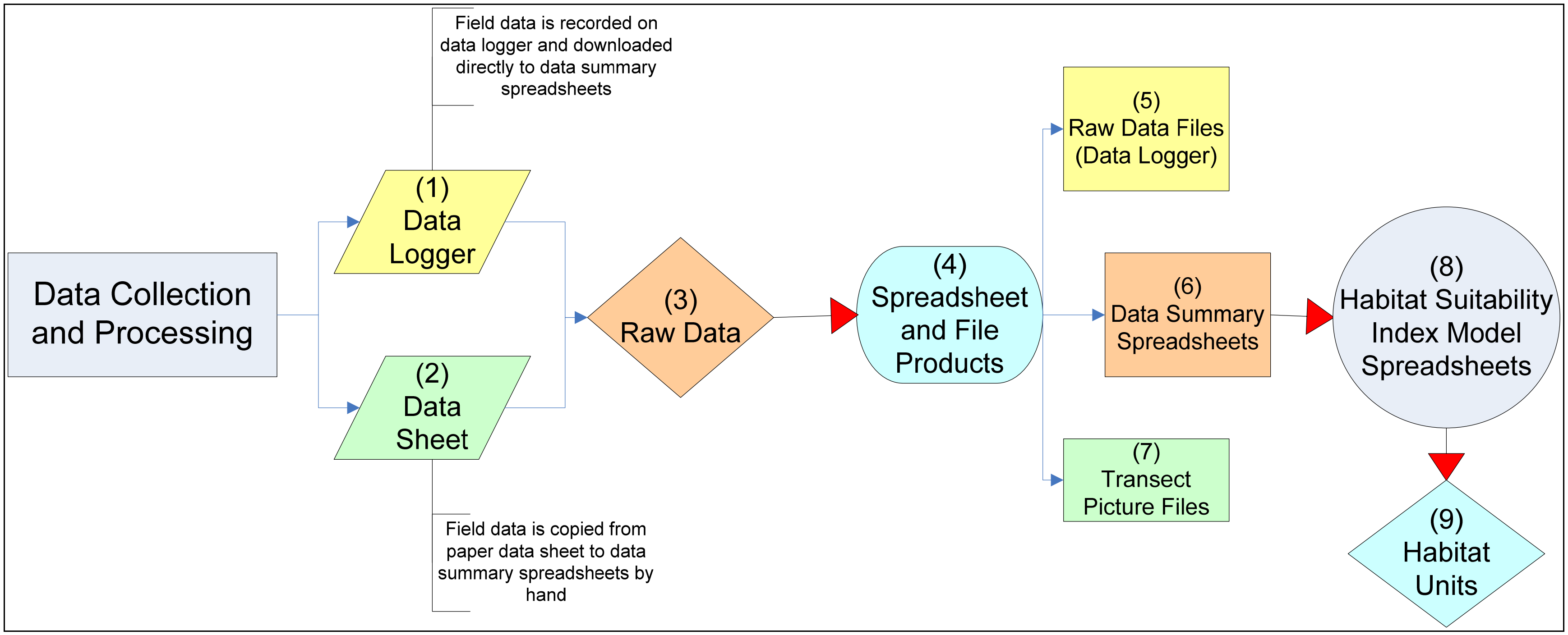

Figure 9. HEP data collection and processing flow chart.

Transect Locations

Transect initial points (IPs) were established based on stratified random sampling protocols with cover types defining the strata. The number of samples initially allocated per cover type strata were determined based on a proportional allocation strategy (Husch et al. 2003). Specific IP locations were identified by overlaying a 100m x 100m grid over cover types and selecting random numbers to identify "XY" point coordinates (P. Ashley, pers. comm.). Random IP locations are shown in Figure 10.

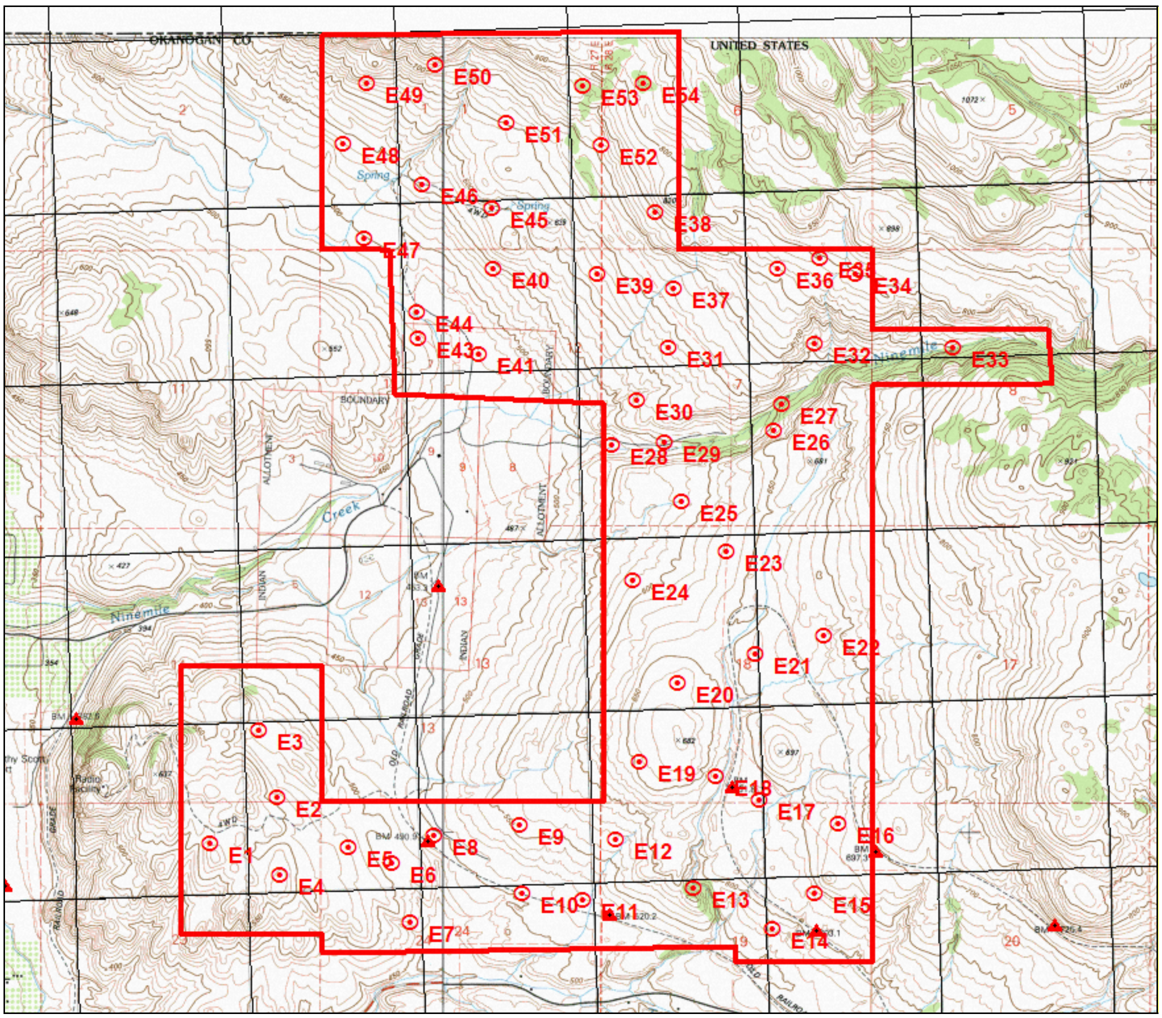

Figure 10. Eder project transect initial points.

The proportional allocation strategy was modified in the field as needed to compensate for the relative homogeneity of a particular cover type, to account for unanticipated access issues and/or physiographic restrictions, and/or to meet temporal considerations. In addition, initial points were moved when they did not fall within the cover type(s) of interest, or were in inaccessible areas such as the middle of a pond or cliff area (additional transect information is located in Appendix B).

Transect UTM coordinates (NAD 27) for start, turn, and end points were recorded in the field on a Garmin IIIA ® GPS unit. Surveyed transect start points are illustrated in Figure 11 (with UTM grid lines) and in Appendix C (aerial photographs). IP/transect UTM coordinates, transect magnetic azimuths, and transect lengths are summarized in Table 5.

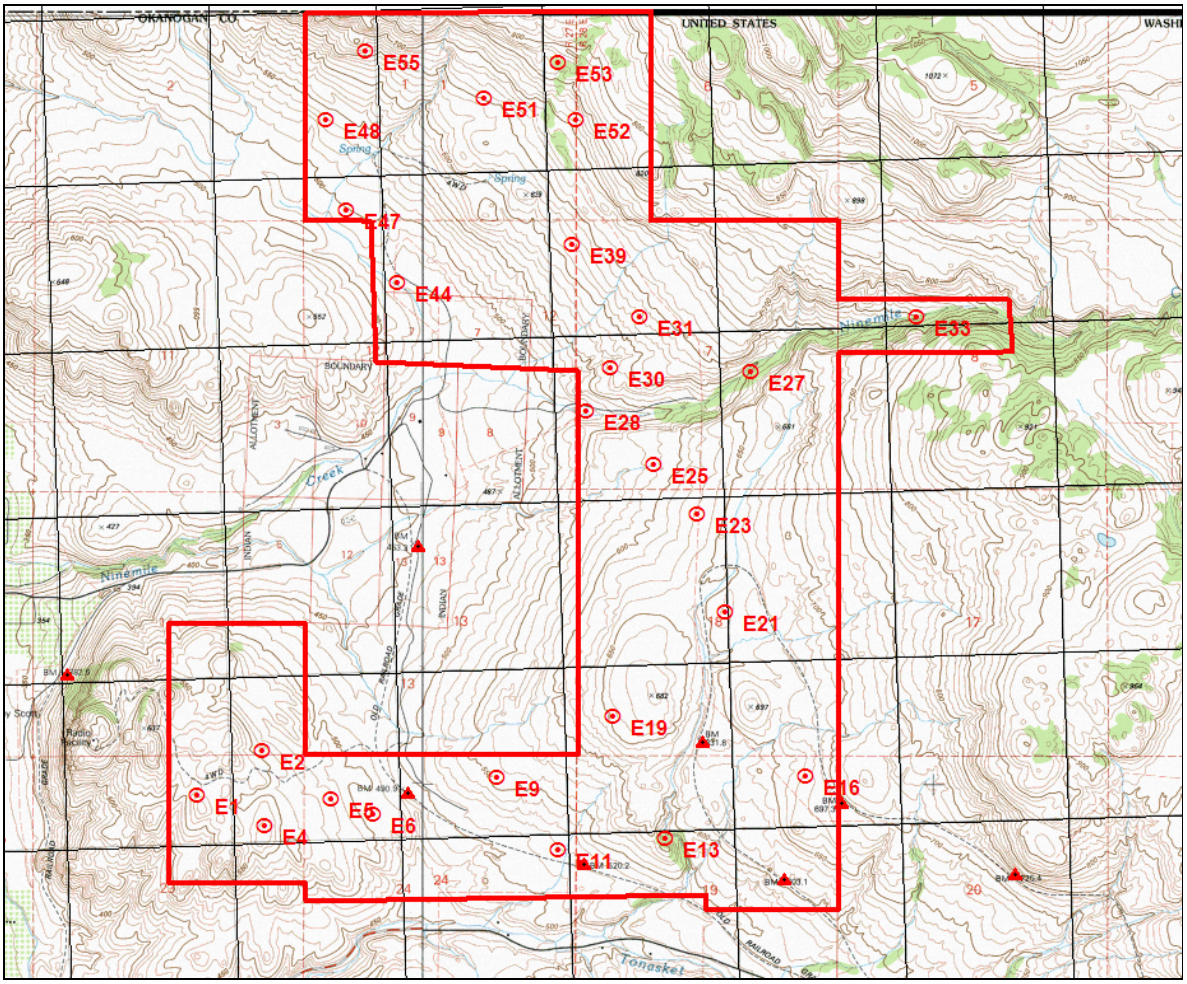

Figure 11. Eder property 2007 HEP transect start points.

Table 5. Eder HEP transect UTM coordinates, magnetic azimuths, and transect lengths.

Transect	Point	GPS		Magnetic Azimuth (Degrees)	Length (Feet)	Total Length
		E	N			
1	start	11 U 0324708	5425250	240	300	**300**
	end	11 U 0324710	5425298			
2	start	11 U 0325204	5425568	260	300	**300**
	end	11 U 0325124	5425602			
4	start	11 U 0325020	5425181	256	300	**300**
	end	11 U 0324925	5425195			
5	start	11 U 0325611	5425236	132	300	**300**
	end	11 U 0325564	5425317			
6	start	11 U 0325848	5425148	024	300	**300**
	end	11 U 0325907	5425207			
9	start	11 U 0326598	5425361	178	300	**300**
	end	11 U 0327402	5425782			
11	start	11 U 0326945	5424905	040	300	**300**
	end	11 U 0327022	5424905			
13	start	11 U 0327675	5424933	Green line	300	**300**
	end	11 U 0327705	5424831			
16	start	11 U 0328441	5425308	070	300	**300**
	end	11 U 0328528	5425310			
19	start	11 U 0327345	5425700	015	300	**300**
	end	11 U 0327402	5425782			
21	start	11 U 0328004	5426314	342	300	**300**
	end	11 U 0328018	5426425			
23	start	11 U 0327840	5426901	348	300	**300**
	end	11 U 0327856	5427002			
25	start	11 U 0327607	5427204	126	300	**300**
	end	Coordinates unavailable				
27	start	11 U 0328232	5427816	Green line	300	**300**
	end	11 U 0328178	5427733			
28	start	11 U 0327215	5427525	Green line	300	**600**
	end	11 U 0327294	5427531			
30	start	11 U 0327350	5427801	138	300	**300**
	end	11 U 0327399	5427707			
31	start	11 U 0327549	5428107	276	300	**300**
	end	11 U 0327479	5428147			
33	start	11 U 0329201	5428059	Green line	300	**300**
	end	11 U 0329095	5428056			
39	start	11 U 0327152	5428551	346	300	**300**
	end	11 U 0327160	5428642			
44	start	11 U 0326095	5428358	158	190	**300**
	turn	11 U 0326113	5428302	100	110	
	end	11 U 0326135	5428291			

Transect	Point	GPS		Magnetic Azimuth (Degrees)	Length (Feet)	Total Length
		E	N			
48	start	11 U 0325694	5429350	307	300	**300**
51	start	11 U 0326650	5429453	ocular		
53	start	11 U 0327101	5429644	120	300	**300**
	end	11 U 0327156	5429586			
55	start	11 U 0325948	5429750	ocular		
69	start	11 U 0326362	5427943	051	300	**300**
	end	11 U 0326478	5427957			

Transect Photo Documentation

Transects were photographed with a Canon G1® 3.3 mega pixal digital camera (with and without magnification). Transect photographs are included in Appendix D.

Photo Methods

Photo points were established at the start point of each transect to document extant habitat conditions. Digital photographs were recorded from a height of three feet at the beginning of each transect facing the same direction as the transect azimuth. A transect reference board[4] was placed at the 15 foot interval while a cover board, divided into 3 inch x 4 inch (8cm x 10cm) rectangles, was set at the 30 foot mark on each transect. Panoramic photographs were also recorded to document dense vegetation, linear/narrow cover types, etc. An example of a photo documentation point is illustrated in Figure 12.

[4] Showing transect number, project name, date, GPS reference number

Figure 12. Photo point example.

Results

A Habitat Evaluation Procedures evaluation was conducted on the Eder property in late July 2007 to assess habitat quality and to determine the number of baseline/protection habitat units (HUs) to credit BPA as partial mitigation for habitat losses associated with Grand Coulee and Chief Joseph Dams. Baseline HEP surveys generated 3,857.64 habitat units or 1.16 HUs per acre. HEP survey results are summarized by cover types and species in Table 6. HEP species models and habitat suitability mathematical aggregations are included in Appendix A.

Table 6. Eder acquisition 2007 HEP results summary.

HEP Model	Variable	Shrubsteppe				Grassland				Total HUs
		Mean SI	HSI	Acres	HUs	Mean SI	HSI	Acres	HUs	
Western Meadowlark	V1: % C.C. Herb. Plants	0.46	0.33	2,346	783.53	0.82	0.82	749	611.78	**1,395.31**
	V2: % Herb. C.C. Composed of Grass	0.93				0.93				
	V3: Ave. Ht. of Herb. Canopy	0.85				0.88				
	V4: Distance to Perch Sites	1.00				1.00				
	V5: % Shrub Canopy Cover	0.56				1.00				
Sharp-tailed Grouse	V1: Mean VOR – Landscape (all vegetation including residual)	0.16	0.39	2,346	913.98	0.15	0.36	749	268.24	**1,182.22**
	V2: Percent Slope	0.77				0.86				
	V3: Percent Cover Grass	0.80				1.00				
	V4: Percent Cover Forbs	0.12				0.18				
	V5: Percent Cover Introduced Herbaceous Species	0.56				0.43				
	V6: Percent Equivalent Optimum Area Providing Nest/Brood Cover	1.00				1.00				
	V7: Distance Between Nesting/Brood Rearing and Winter Habitat	1.00				1.00				
	V8: Percent Cover Deciduous shrubs and Trees	(see riparian shrub)								
	V9: Deciduous Shrub and Tree Composition/Wheat Availability	(see riparian shrub)								
	V10: Percent Equivalent Optimum Area Providing Winter Habitat	(see riparian shrub)								
Mule Deer	V1: Percent cover of preferred shrubs <1.5 meters in height	0.53	0.43	2,346	1,005.72	0.01	0.17	749	130.04	**1,135.77**
	V2: Percent cover of all shrubs <1.5 meters in height.	0.53				0.01				
	V3: Mean shrub height.	0.47				0.11				
	V4: Number of preferred shrub species.	0.62				0.06				
	V5: Percent cover of palatable herbaceous species.	0.93				1.00				
	V6: Presence of suitable agricultural crops within 1.6 kilometers (1 mile) of study area	0.10				0.10				
	V7: Aspect	0.60				0.60				
	V8: Road density	1.00				1.00				
	V9: Topographic diversity	1.00				1.00				
	V10: Percent evergreen canopy >1.5 meters in height	0.00				0.00				
Total				**2,346**	**2,703.23**			**749**	**1,010.06**	**3,713.29**
		Rockland								
Bobcat	V1: Percent cover herbaceous vegetation	0.80	0.73	135	99.00					99.00
	V2: Shrub distribution	0.70								
	V3: Percent shrub cover	0.30								
	V4: Percent area comprised of rock outcrops, boulders, etc.	1.00								
Total				**135.00**	**99.00**					**99.00**
		Riparian Shrub								
Sharp-tailed Grouse (winter)	V8: Percent Cover Deciduous shrubs and Trees	0.45	0.05	23	1.24					1.24
	V9: Deciduous Shrub and Tree Composition/Wheat Availability	0.65								
	V10: Percent Equivalent Optimum Area Providing Winter Habitat	0.10								
Total				**23.00**	**1.24**					**1.24**
		Riparian/Conifer Forest								
Downy Woodpecker	V1: Basal Area	0.53	0.53	84	44.10					44.10
	V2: Number of snags >15 cm dbh/0.4 ha (> 6 inches dbh/ 1.0 acre).	0.75								
Total				**84**	**44.10**					**44.10**
Project Total				**3,337**						**3,857.64**

Discussion

HSI Summary

Comments are limited to HEP model species that received a habitat suitability index rating less than 0.50. Western meadowlark, bobcat, and downy woodpecker habitat suitability indices were 0.82 (grassland cover type), 0.73 and 0.53 respectively and, therefore, will not be addressed in this section (Table 6).

In general, few forbs species were detected on transects which may have been due to a combination of livestock grazing and the late timing of the surveys. Similarly, visual obstruction readings (VOR) were lower than expected; likely a direct result of livestock impacts. Exotic herbaceous species including cultivated pasture grasses e.g., crested wheatgrass (*Agropyron cristatum*) and/or invader species such as cheatgrass and mustard were observed in most areas surveyed.

Western Meadowlark

Western meadowlark model output suggests that habitat quality within the shrubsteppe cover type was marginal (0.33 HSI) largely because of the amount of shrub cover present and the relatively low suitability index for variable 1, “percent cover of herbaceous species”. When livestock grazing ceases and/or is reduced significantly, herbaceous cover should increase resulting in improved western meadowlark habitat suitability. In contrast, shrub cover will likely remain static, or increase only slightly.

Sharp-tailed Grouse

Sharp-tailed grouse habitat suitability was marginal in both grassland and shrubsteppe cover types (0.36 HSI and 0.39 HSI respectively). In both cover types, low VOR was the primary factor limiting nesting and brood rearing habitat quality suitability. Less than desirable floristic composition resulting from the relatively high occurrence of non-native invasive plant species and the lack of forbs also contributed towards reduced HSI ratings.

The low habitat suitability rating generated in the riparian shrub cover type (<0.10 HSI), which provides winter food and escape cover, was due primarily to the limited extent of this cover type on project lands. Increasing the amount of the riparian shrub cover type would increase the model HSI and generate additional habitat units.

If adjacent off-site areas were considered in HEP evaluations, i.e. at the landscape level, the sharp-tailed grouse winter habitat suitability index would likely increase because winter habitat is present on adjacent lands. To date, project managers throughout the Columbia Basin have included only mitigation lands in HEP evaluations as a result of the well founded concern for lack of management control on adjacent privately owned lands. It could be argued, however, that adjacent public lands or lands held in “Trust” should be considered in HEP evaluations if Tribal, Federal, or State management mandates and/or statutes protect habitat quality.

Mule Deer

Currently, mule deer habitat quality is “fair” (0.43 HSI) in the shrubsteppe cover type. Passive management that allows the percent cover of palatable shrubs to increase would improve winter foraging conditions for mule deer and HEP model HSI output. In contrast, mule deer habitat quality is rated “poor” (0.17 HSI) in the grassland cover type due to the lack of palatable shrubs. If WDFW management objectives call for keeping grassland structure intact i.e., less than 5% shrub cover, then the HSI will remain “static”.

Note that “percent palatable shrub cover” (V1) is a key habitat variable that significantly influences the mule deer HEP model output. If shrubs are not present or limited, the model HSI will be low even if all other variables are optimum. This artificially constrains model habitat suitability if applied to cover types with limited shrub cover. Modifying the existing HEP model to include rating habitat variables at the landscape level, similar to what was done with the white-tailed deer model on the Spokane Indian Reservation (Ashley 2005), is a biologically reasonable option to address use of the model in cover types that lack palatable shrubs, but are still used by mule deer.

Acknowledgements

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References

Ashley, P. R., and M. Berger 1999. Habitat suitability model mule deer (winter). Olympia WA: Washington Department of Fish and Wildlife. Nespelem, WA: Colville Confederated Tribes.

Ashley, P. R. 2003. Sharp-tailed grouse HEP model. Olympia WA: Washington Department of Fish and Wildlife.

_____. 2005. White-tailed deer HEP model *(draft)*. Portland, OR: Columbia Basin Fish and Wildlife Authority. Wellpinit, WA: Spokane Tribe of Indians.

_____. 2006. Habitat evaluation procedures standard measurement protocols and techniques (*draft*). Columbia Basin Fish and Wildlife Authority (CBFWA). Portland, OR.

Avery, T.E., H. E. Burkhart. 1994. Forest measurements. 4th edition. New York, NY: John Wiley and Sons.

Berger, M. T. and D. Kuehn. 1992. Wildlife impact assessment Chief Joseph Dam Project. Project N0. 88-44. Bonneville Power Administration. Portland, OR.

Bodurtha, Tim. 1991. Unpublished habitat suitability index model: Bobcat. U. S. Fish and Wildlife Service.

BPA/WDFW. 1996. Memorandum of Agreement between the Washington Department of Fish and Wildlife and Bonneville Power Administration for the disbursal of wildlife mitigation funds and mitigation crediting. WDFW. Olympia, WA. BPA. Portland, OR.

Gotelli, N. J., A. M. Ellison. 2004. A primer of ecological statistics. Sinauer Associates, Inc. Sunderland, MA.

Hays, R. L., C. Summers, and W. Seitz. 1981. Estimating habitat variables. Western Energy and land Use Team. Fort Collins, CO: U.S. Fish and Wildlife Service.

Howerton, J., J. Creveling, and B. Renfrow. 1986. Wildlife protection, mitigation, and enhancement planning for Grand Coulee Dam. Olympia, WA: Washington Department of Fish and Wildlife.

Husch, B., T.W. Beers, and J.A. Kershaw, Jr. 2003. Forest mensuration- 4th edition. Hoboken, NJ: Wiley and Sons, Inc.

Robel, R.J., J. N. Dayton, A.D. Hulbert. 1975. Relationship between visual obstruction measurements and weight of grassland vegetation**.** *Journal of Range Management*. 23: 295.

Schroeder, R.L. 1982. Habitat suitability index models: Downy woodpecker. U.S. Department of the Interior, Fish and Wildlife Service. FWS/OBS-82/10.38.

Schroeder, R.L., and P.J. Sousa. 1982. Habitat suitability index models: Eastern meadowlark. U.S. Department of the Interior, Fish and Wildlife Service. FWS/OBS-82/10.29.

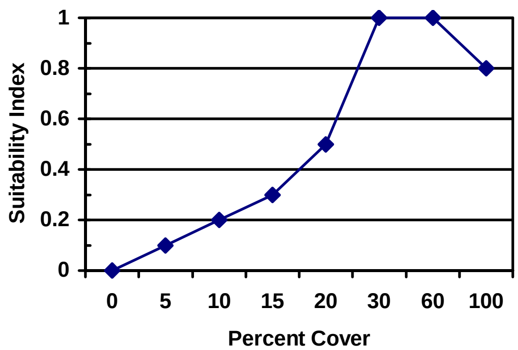
USFWS. 1980. Habitat as a Basis for Environmental Assessment, Ecological Services Manual (ESM) 101. Division of Ecological Services, U. S. Fish and Wildlife Service, Washington, DC: Department of the Interior.

______. 1980a. Habitat Evaluation Procedures (HEP), Ecological Services Manual (ESM) 102. Division of Ecological Services, U.S. Fish and Wildlife Service, Washington, DC: Department of the Interior.

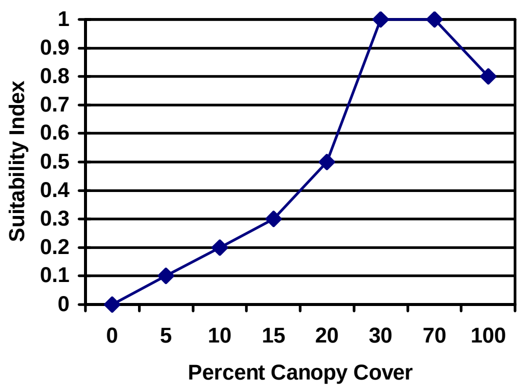
Appendix A – Abbreviated HEP Models

Mule Deer

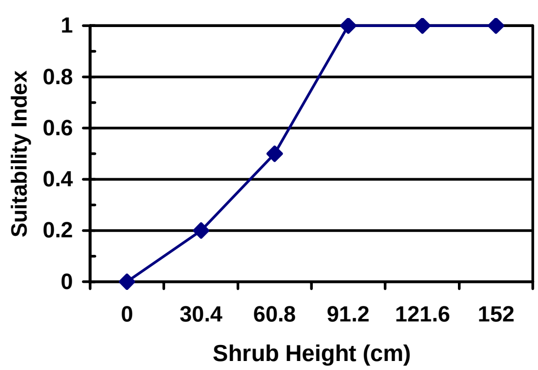
V1: Percent palatable shrub cover < 5 ft in height

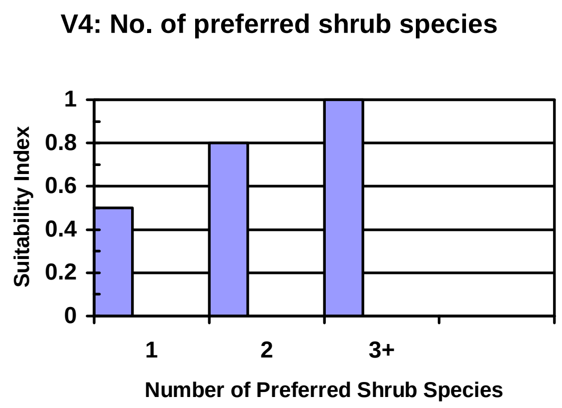


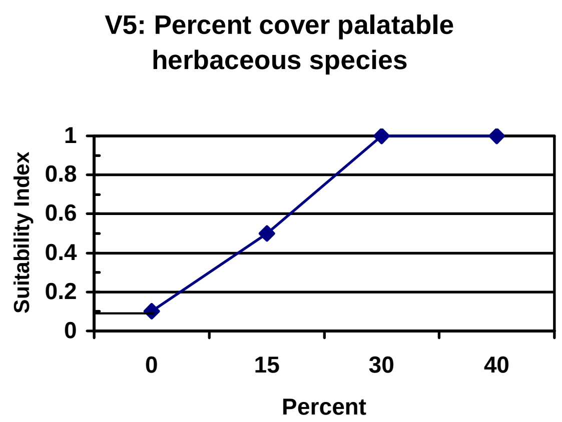
V2: Percent cover all shrubs < 5 ft in height



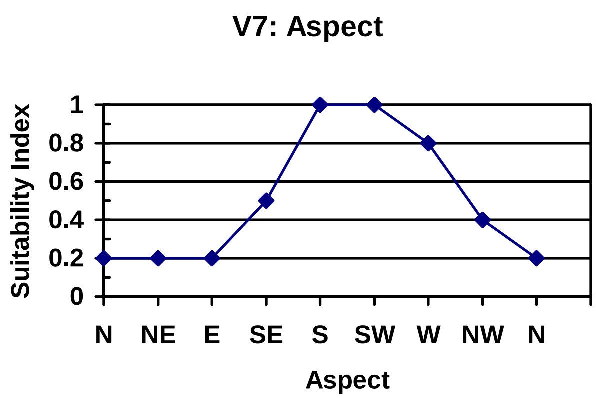
V3: Mean shrub height

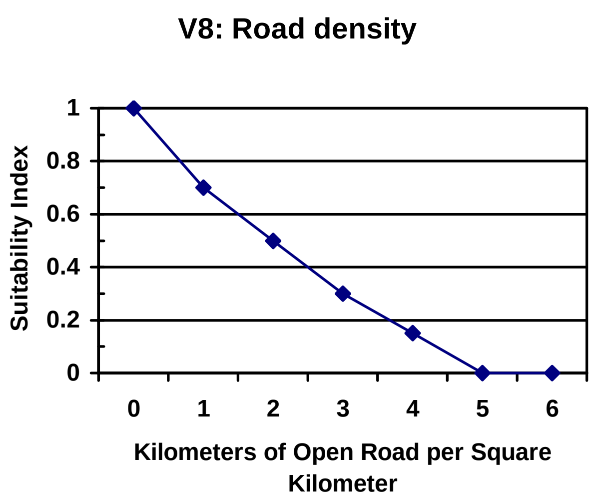


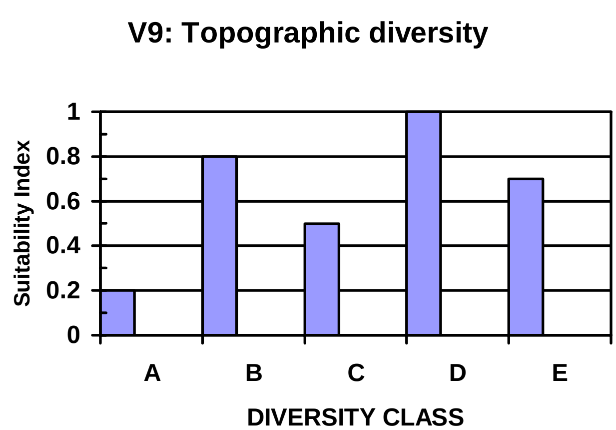




V6: Presence of suitable agricultural crops within 1.6 kilometers (1 mile) of study area
Yes: 0.1
No: 0.0

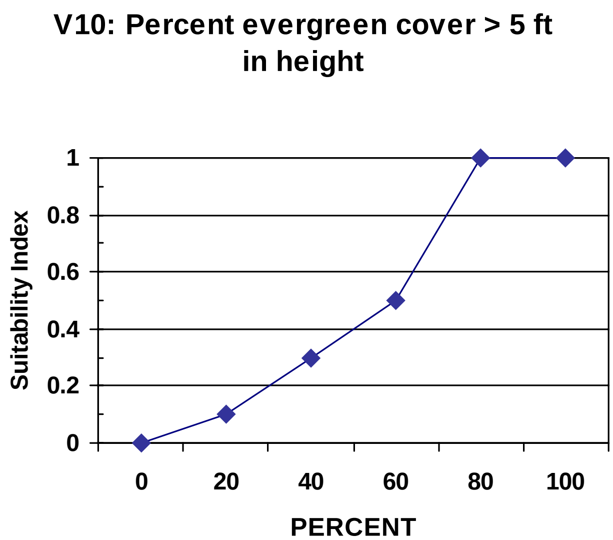

V7: Aspect
Suitability Index
1
0.8
0.6
0.4
0.2
0
N
NE
E
SE
S
SW
W
NW
N
Aspect


V8: Road density
Suitability Index
1
0.8
0.6
0.4
0.2
0
0
1
2
3
4
5
6
Kilometers of Open Road per Square Kilometer


V9: Topographic diversity
Suitability Index
1
0.8
0.6
0.4
0.2
0
A
B
C
D
E
DIVERSITY CLASS

V_9 Topographic diversity.

A: Level terrain less than 5 percent slope.
B: Level terrain broken by drainages.
C: Rolling terrain 5 to 25 percent slope.
D: Rolling terrain with rims, ridges, and/or drainages.
E: Mountainous terrain with slopes greater than 25 percent.



Shrubsteppe HSI = minimum value WFI or WCI

WFI = (((V1 (V2 x V3 x V4 x V5) ¼) + V6) x V7)^ $^{.625}$ x V8

<u>Steps in calculating WFI with a hand calculator</u>:

1. Obtain geometric mean of V2, V3, V4, and V5
2. Multiply product from step one by V1 and add V6
3. Multiply sum obtained in step two by V7
4. Take the 1.66 root (^.6 on your computer)of product from step 3
5. Multiply result from step 4 by V8 to obtain WFI

WCI_{SS} = (V9 x .8) + V10

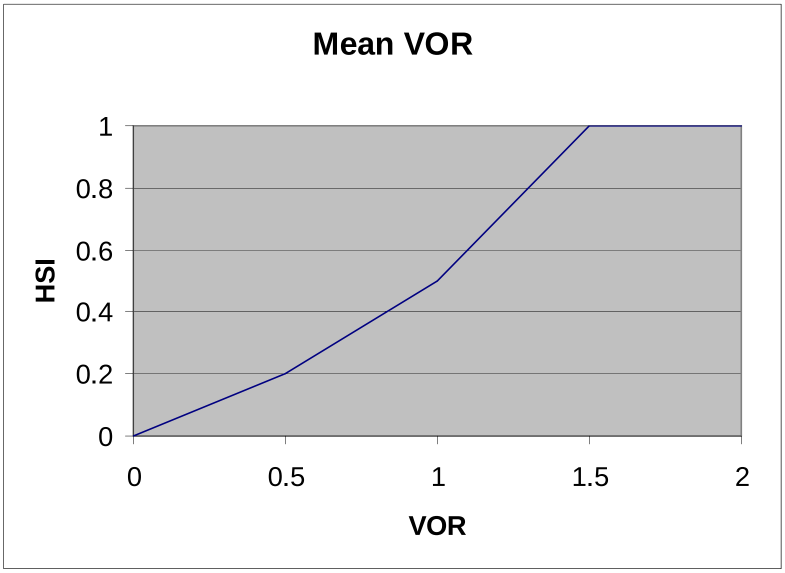
Conifer Forest HSI = Lower Value Between:

WFI = (((V1 (V2 x V3 x V4 x V5) ¼) + V6) x V7)^ $^{.625}$ x V8

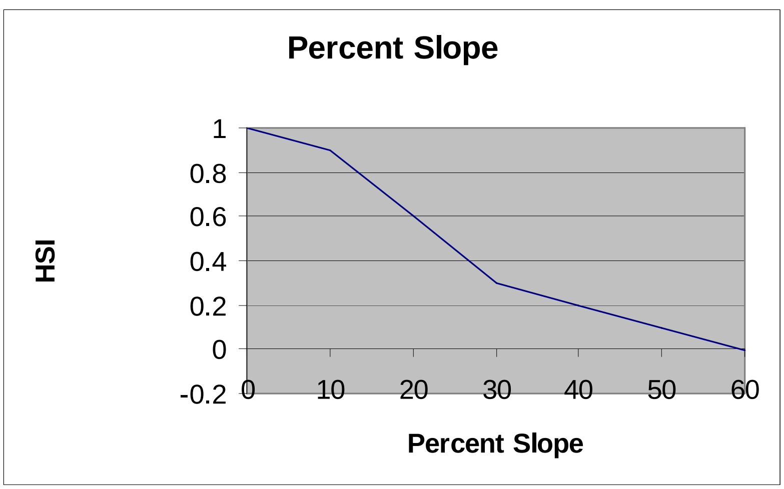
$$WCI_F = \frac{2(V10) + V9}{3}$$

Sharp-tailed Grouse

V1: Mean VOR – Landscape (all vegetation including residual)



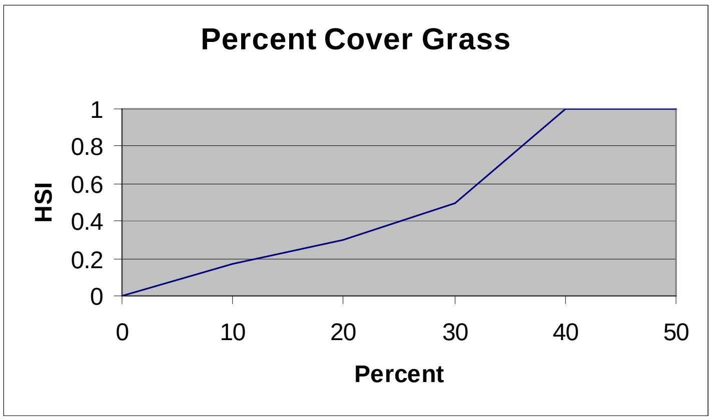
V2: Percent Slope



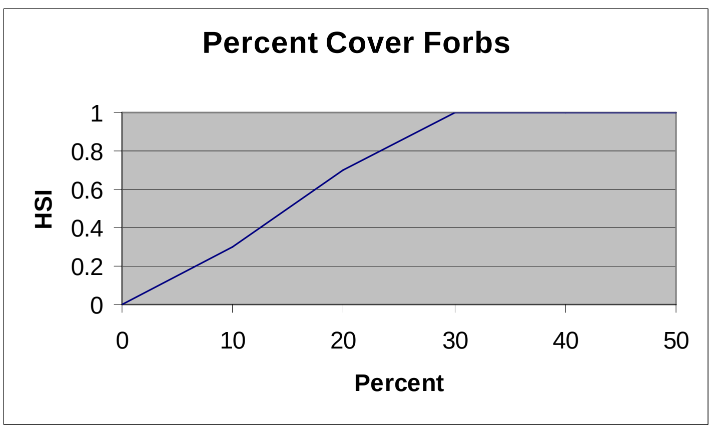
<u>**Nesting Habitat HSI Equation:**</u> **$(V1 \times V2 \times V6)^{1/2}$**

Brood Rearing Habitat

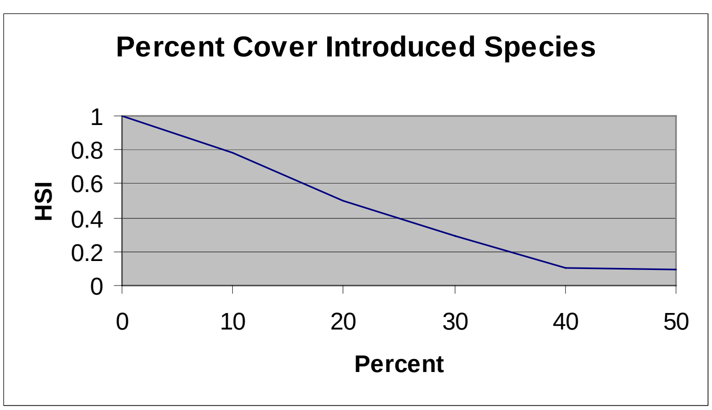
V3: Percent Cover Grass



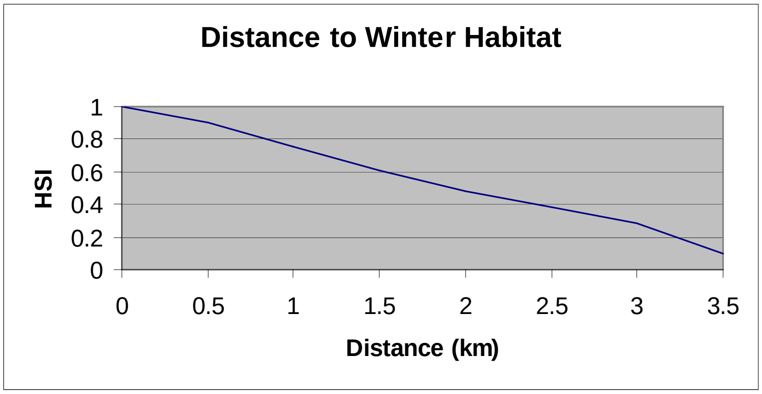
V4: Percent Cover Forbs



V5: Percent Cover Introduced Herbaceous Species



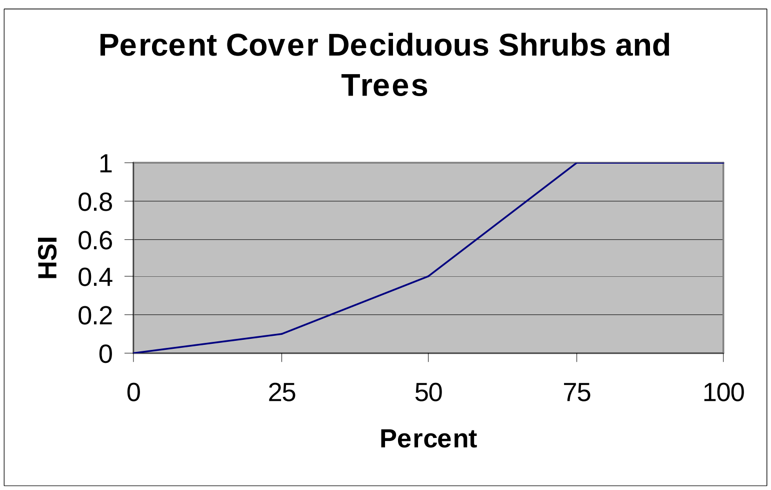
V7: Distance Between Nesting/Brood Rearing and Winter Habitat



Brood Rearing HSI Equation: $[[((V3 + V4)/2)(V6)(V7)]^{1/3}(V5)]$
Nesting/Brood Rearing HSI = (Nesting HSI x Brood Rearing HSI)$^{1/2}$

Winter Habitat

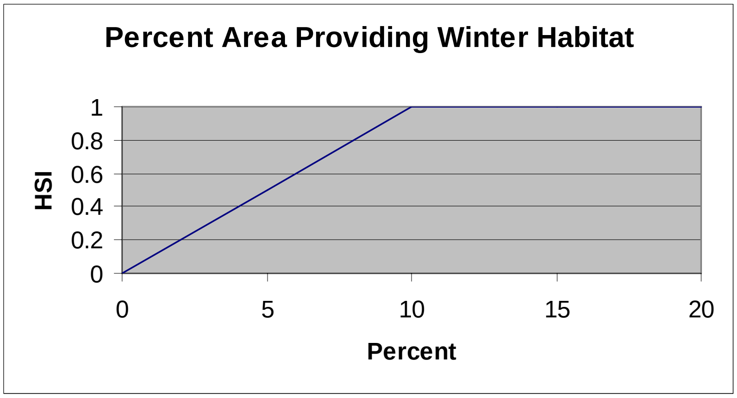
V8: Percent Cover Deciduous Shrubs and Trees



V9: Deciduous Shrub and Tree Composition/Wheat Availability

Attribute	**Species**	SI
Upper Canopy	Water Birch, Aspen, Cottonwood	0.5
Mid Canopy	Serviceberry, Hawthorn, Chokecherry	0.3
Lower canopy	Rose, Snowberry	0.2
Agricultural Fields	Standing Wheat or Wheat Stubble	0.2
HSI	**Additive : Not to exceed 1.0**	1.2 = 1.0

V10: Percent Area Providing Winter Habitat



<u>Winter HSI Equation: (</u>(V8 x V9)$^{1/2}$ x V10)

<u>Model HSI:</u> Consists of two HSI's: Nesting/Brood Rearing HSI and Winter HSI.

<u>Total Habitat Units =</u> Sum of Winter Habitat + Nesting/Brood Rearing Habitat Units

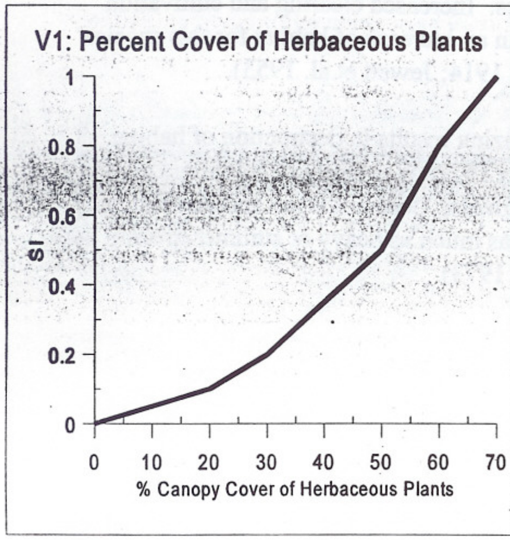
Western Meadowlark

WESTERN MEADOWLARK

Modified from Schroeder and Sousa, 1982.

Cover Types: Grassland, Shrubgrass, Shrubland, Pasture, Shrub-steppe

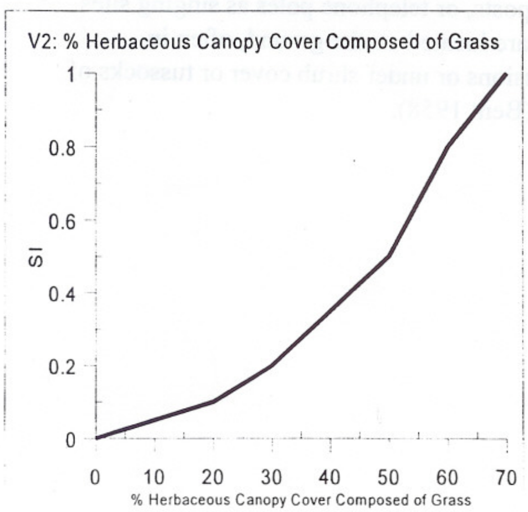
V1: Percent canopy cover of herbaceous plants



Cover Requirements

Western meadowlarks are adapted to short grass and mixed grass prairies, preferring large fields with short vegetation and good drainage. Western meadowlarks exhibit tolerance for a wide variety of plant associations and are widely distributed in Washington-commonly occurring in meadows, orchards, thickets, and cultivated areas. Conversion of woodlands to agricultural fields has favored western meadowlark populations in Washington.

V2: Percent of herbaceous canopy cover composed of grass

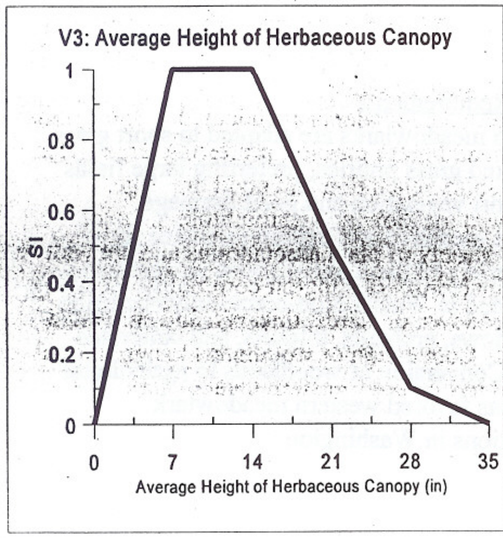


Food Requirements

Bryant (1914), Weins (1973) et.al. suggest that animal material, primarily insects, comprise approximately 63% of the meadowlark's diet while 37% is made up of vegetative matter. Vegetable matter consisted of one-third grain and two-thirds weed seeds. Spring and summer diet was primarily insects with a shift to seeds in fall and winter. Hubbard and Hubbard (1969) reported meadowlarks eating carrion including their own species. It is doubtful that food supply is ever a limiting factor for this species (Lanyon, 1956).

Water Requirements

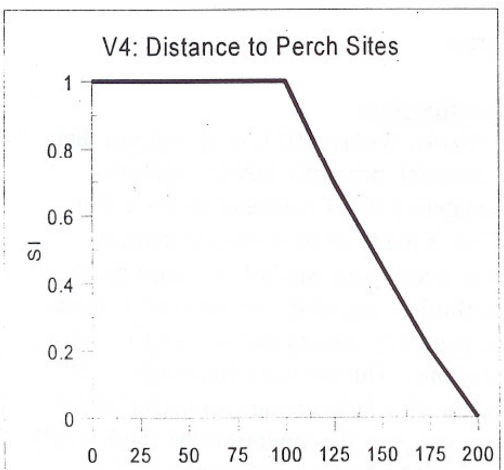
V3: Average height of herbaceous canopy (inches)



Because of its habitat preferences, western meadowlarks are affected by agricultural activities. Increased clearing and cultivation results in an increase of habitat for this species (Bryant 1914; Jewett et.al. 1953).

Overgrazing results in destruction of habitat (Rohwer 1972; Weins 1973). Light grazing or winter grazing does not affect meadowlark habitat as much as heavy or summer grazing (Weins 1973).

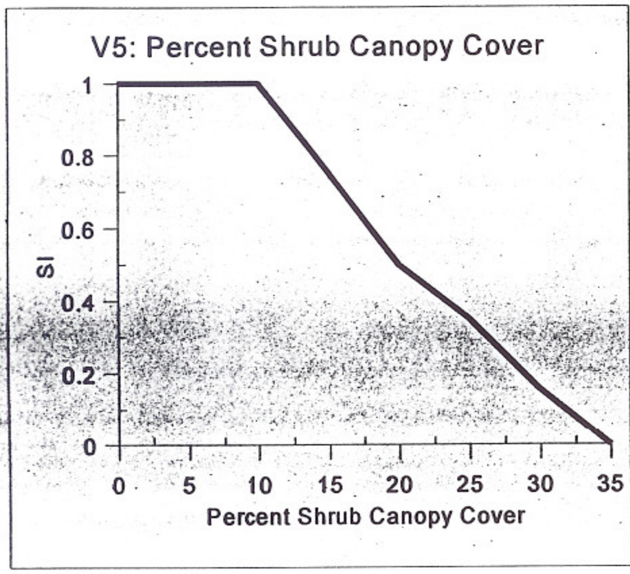
V4: Distance to Perch Sites (feet)



Reproductive Requirements

Males require elevated perches, such as shrubs, fence posts, or telephone poles as singing sites. Nests are located on the ground, often in depressions or under shrub cover or tussocks of grass (Bent 1958).

V5: Percent Shrub Canopy Cover



Model Equation:

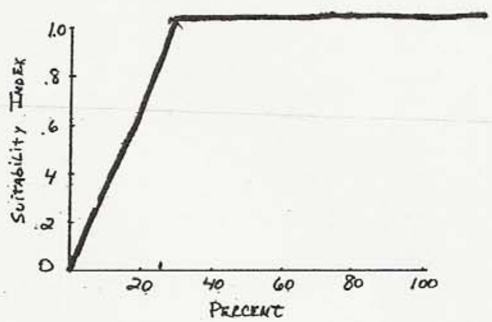
HSI = (V1 x V2 x V3 x V4)½ x V5

Bobcat

Variable 4. Percent of area comprised of rockpiles, rock outcrops, rocky ledges, boulder fields, talus slopes and cliffs [include only tops and bottoms of cliffs and not cliff faces (pers comm., Steve Knick)].

Assumes:

(1) Bobcats prefer rocky or broken terrain.



Model Relationships

In order to calculate suitability indices for food and for cover, the variables for each life requisite were combined into an equation. Because food requirements and cover/reproductive requirements are of equal importance, the SI's were derived to express each life requisite as separate values for the overall HSI determination (see below).

Suitability Indices

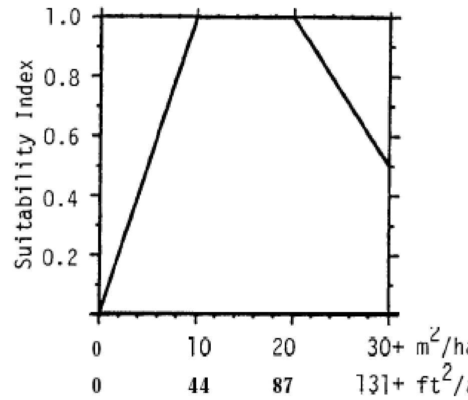
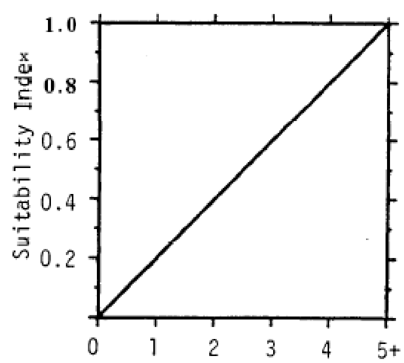
<u>Food</u>

$$SI_f = \frac{V1 + 2V2}{3}$$

<u>Cover/reproduction</u>

$$SI_{c/r} = \frac{V3 + 2V4}{3}$$

Downy Woodpecker

Cover type	Variable		Suitability graph
EF, DF, EFW, DFW	V_1	Basal area.	
EF, DF, EFW, DFW	V_2	Number of snags > 15 cm dbh/0.4 ha (> 6 inches dbh/ 1.0 acre).	

<u>Life requisite values</u>. The life requisite values for the downy woodpecker are presented below.

Life requisite	Cover type	Life requisite value
Food	EF,DF,EFW,DFW	V_1
Reproduction	EF,DF,EFW,DFW	V_2

HSI determination. The HSI for the downy woodpecker is equal to the lowest life requisite value.

Application of the Model

Definitions of variables and suggested field measurement techniques (Hays et al. 1981) are provided in Figure 2.

Variable (definition)		Cover types	Suggested technique
V_1	Basal area [the area of exposed stems of woody vegetation if cut horizontally at 1.4 m (4.5 ft) height, in m^2/ha (ft^2/acre)].	EF,DF,EFW,DFW	Bitterlich method
V_2	Number of snags > 15 cm (6 inches) dbh/0.4 ha (1.0 acre) [the number of standing dead trees or partly dead trees, greater than 15 cm (6 inches) diameter at breast height (1.4 m/4.5 ft), that are at least 1.8 m (6 ft) tall. Trees in which at least 50% of the branches have fallen, or are present but no longer bear foliage, are to be considered snags].	EF,DF,EFW,DFW	Quadrat

Appendix B – Measurement Protocols

HABITAT EVALUATION PROCEDURES

STANDARD MEASUREMENT PROTOCOLS AND TECHNIQUES (Draft)

Compiled By
Paul R Ashley – RHT Coordinator
November 2006

HEP Sampling Design and Measurement Protocols

Introduction
This document was developed to fulfill a request by the Upper Columbia United Tribes (UCUT) and Bonneville Power Administration (BPA) to develop a "stand alone" reference for Habitat Evaluation Procedures (HEP) transect protocols used by the Regional HEP Team (RHT). General and specific protocols are described. General protocols include a brief description of pre HEP survey pilot studies; transect establishment guidelines, and photo documentation parameters. In contrast, specific metrics detail actual habitat variable measurement techniques including diagrams where additional explanation is needed.

Specific metrics are identified with an alpha-numeric code. This allows project managers and others to identify specific measurement techniques in report tables without lengthy, redundant explanations. This report is intended to be a "living" document and will be modified as needed. The following standardized protocols and measurement techniques are used by the Regional HEP team to measure habitat variables described in HEP models.

General Protocols

Pilot Studies
Pilot studies are conducted in new habitat types and/or familiar habitat types that are comprised of unique structural conditions/key ecological correlates. Pilot study data is used to estimate the sample size needed for a confidence level ≥ 80% with a 10% tolerable error level (Avery 1994) and to determine the most appropriate sampling unit[5] for the habitat variable of interest i.e., a coefficient of variation analysis (BLM 1998). In addition, a power analysis is conducted on pilot study data (and periodically throughout data collection) to ensure that sample sizes are sufficient to identify a minimal detectable change of 20% in the variable of interest with a Type I error rate ≤0.10 and P = 0.9 (BLM 1998, Block et al. 2001). All field data is recorded on data loggers or data sheets and downloaded/transferred to data summary spreadsheets.
Transects
Transect cover sheets are used to document specific transect information including transect identification, cover type, HEP Team members, global positioning system (GPS) coordinates, and other pertinent information.
Transects are established at least 300 feet (100 meters), where possible, from ecotones, roads, and other anthropogenic influences. Transect starting points and azimuths (direction) are randomly selected for each cover type. Start points are selected based on superimposing a UTM grid over cover type maps and identifying specific X/Y coordinates with the aid of a random numbers table, or computer generated random number generator/point locater program.

[5] Includes micro-plot grid size and shape etc.

Transect start, turn, and end points are marked with 14-inch (36 centimeter) 0.25 inch (0.6 centimeter) diameter rebar stakes[6] painted fluorescent orange or red. GPS positions (UTM coordinates-NAD 27) are recorded at start, turn, and end points. If cover types change or transect length is greater than 300 feet, another transect azimuth is randomly selected, or the original azimuth is varied by 45 degrees (direction [left or right] is determined by the flip of a coin where more than one choice is possible). Compass azimuths (headings) are magnetic bearings i.e., not corrected for local declination. Transects are divided into 100 foot (30 meter) sample units for statistical purposes.

Photo Points

Photo points are established at the start point of each transect. Pictures are recorded from a height of three feet at the beginning of each transect while facing in the direction of the transect azimuth. A transect reference board (includes transect number, project name, date, GPS reference number) is placed at the 15 foot interval while a cover board is placed at the 30 foot mark on each transect. Occasionally, panoramic photographs are also needed e.g., dense vegetation, linear/narrow cover types. Habitat conditions are photographed with a Canon G1® 3.3 mega pixal digital camera (with and without magnification).

Specific Metrics

Metrics generally follow those described by Hays et al. (1981) and/or Avery (1994) unless otherwise noted. Some metrics have been modified due to extreme field conditions and/or to better meet Regional HEP Team needs.

Herbaceous Measurements

Percent Cover

1. Herbaceous percent cover measurements are recorded at 20 or 25-foot intervals on the right side of the transect tape (the right side is determined by standing at 0 feet and facing the line of travel/transect azimuth). RHT members walk on the left side of the transect line to reduce sample disturbance. A square $0.1m^2$ micro-plot grid is used in grasslands to estimate percent cover of herbaceous vegetation while a rectangular $0.5m^2$ grid is generally used in shrublands (the $0.5m^2$ grid may also be used in grasslands if desired). The near right hand corner of the grid is placed at the sampling interval (rectangle grids are placed with the long axis perpendicular to the tape, and the lower right corner on the sampling interval). An example of micro-plot grid placement is shown in Figure 1. Approximately 20% of the micro plot is covered by vegetation in the example. Grid samples are considered independent samples for statistical purposes.

    1A: $0.1m^2$ micro-plot grid/20' interval

[6] Marking transect points with rebar stakes is at the discretion of the project proponent. Therefore, not all transects are marked in this manner.

1B: 0.1m^2 micro-plot grid/25' interval
1C: 0.5m^2 micro-plot grid/20' interval
1D: 0.5m^2 micro-plot grid/25' interval

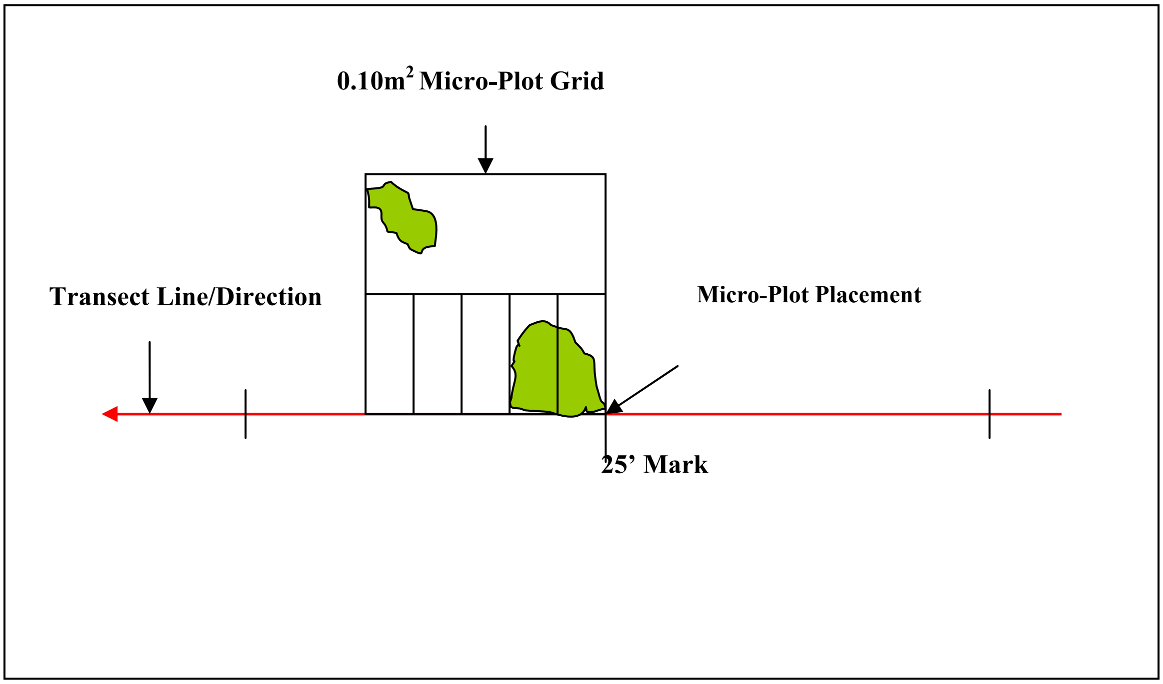


Figure 1. Micro-plot grid placement and percent cover example.

Height

2. Herbaceous height is measured with a measuring rod placed within the grid frame (scale = 10ths/ft.). Three evenly spaced measurements are recorded and averaged for each sample. Only leaf material is measured (leaves provide the greatest amount of cover). "Leaf material" may include residual cover and/or new growth predicated on HEP model variable requirements. Grass inflorescence is not included in height measurements.

2A. Four measurements, one from each corner of the micro plot grid, are recorded and averaged for each sample. Only leaf material is measured (leaves provide the greatest amount of cover). Grass inflorescence is not included in height measurements.

2B. A measuring rod is held vertical at the interval point: the highest vegetation to cross the measuring rod at that point is measured to the nearest tenth of a foot.

2B-1: 10' interval
2B-2: 20' interval
2B-3: 25' interval

Visual Obstruction Readings (VOR)

3. A Robel pole (Robel 1975) is used to document vertical and/or horizontal cover for herbaceous vegetation i.e., visual obstruction readings (VOR). Measurements are recorded at 20, 25, or 50-foot intervals. Intervals are determined by the length of each transect, i.e., a minimum of 12 measurements are required for each transect, or cover type heterogeneity (structurally diverse cover types generally require larger sample sizes).
The Robel pole (Robel 1975) is placed on the transect line at the appropriate interval. Four observations are taken from a distance of four meters from the Robel pole and averaged to obtain a single visual obstruction reading or VOR. Observers sight over a one meter pole and record how much of the Robel pole is totally obscured from the ground up (Figure 2). Measurements are reported in 0.25 decimeter increments.
Two measurements are taken on the transect line on opposite sides of the Robel pole; two identical measurements are taken from the same point perpendicular to the transect line for a total of four "readings" (Figure 3). Sample size is determined to be adequate when the "running mean" varies ≤ 10% of the mean. VOR samples are considered independent for statistical purposes.

3A: 20' interval
3B: 25' interval
3C: 50' interval

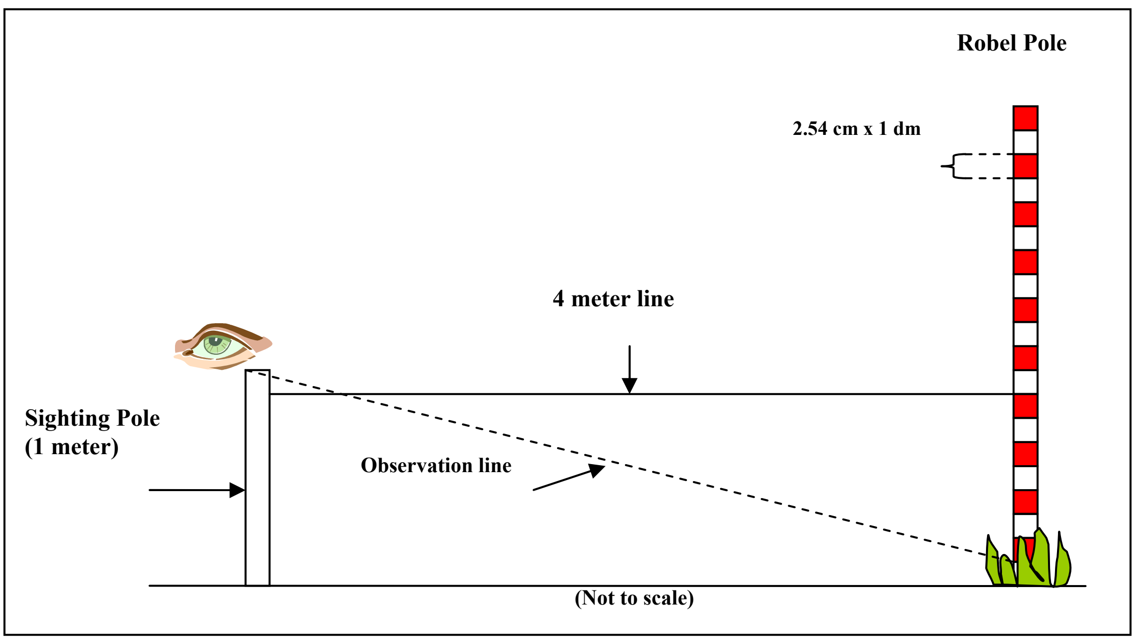


Figure 2. Visual obstruction reading diagram.

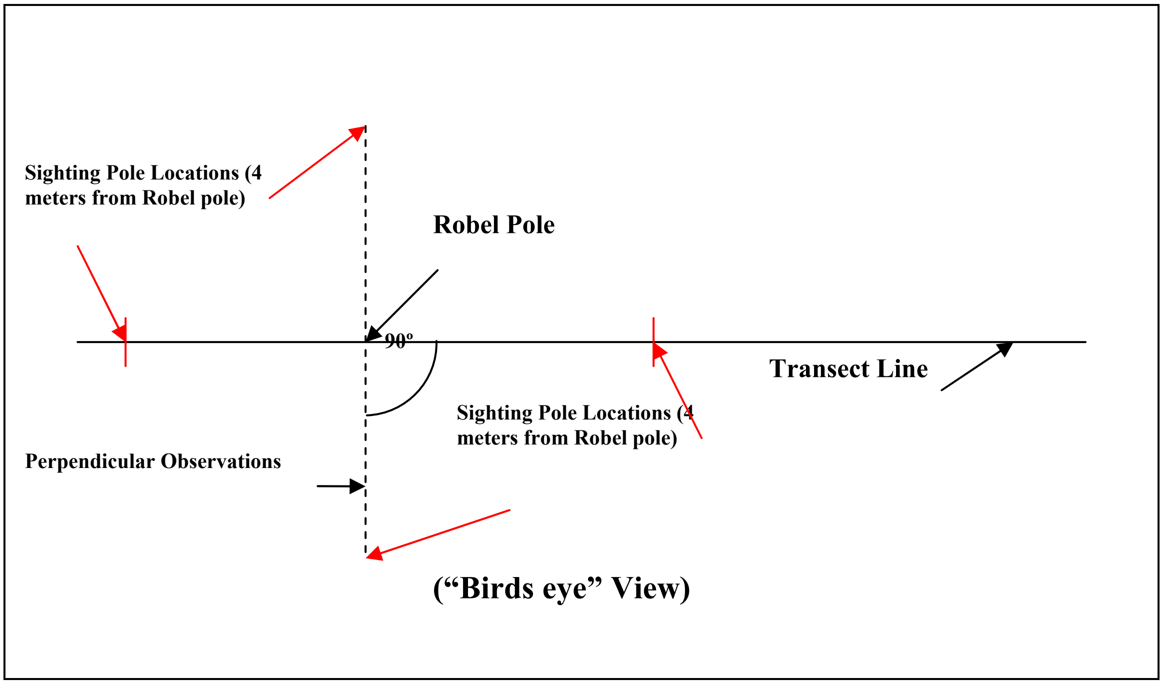


Figure 3. Robel pole "readings" layout diagram.

Shrub Measurements

Percent Cover

4. Line intercept or point intercept (USFWS 1981) is used to determine shrub cover. Line intercept is generally used when shrub cover is estimated at < 5% (the most accurate results are obtained using the line intercept method). In contrast, the point intercept method is used if shrub cover is estimated at > 5%.

4A: Line intercept is used to measure the amount of cover that intercepts the transect line as illustrated by the red lines shown in Figure 4. Measurements are in 10^{ths} of feet. Gaps in vegetation less than four tenths of a foot (5 inches) are ignored. The amount covered by shrubs is added to determine shrub intercept for each transect. For example, if 7.5 feet of a 100-foot long transect is covered by shrubs, percent cover is 7.5%.

Shrub cover is recorded by species. Where shrubs overlap, shrub intercept is recorded for the tallest shrub and noted for the lower shrub(s).

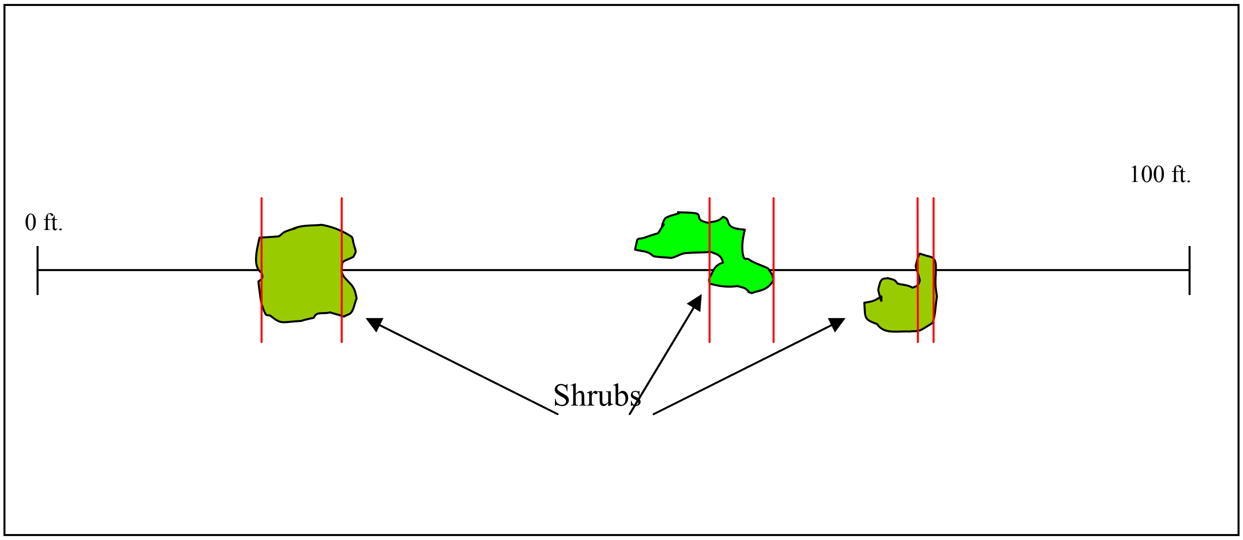


Figure 4. Line intercept method example.

4B: Point intercept is used when shrub canopy cover is estimated at ≥5%. Shrub cover is determined by recording the number of “hits” at specific intervals along a transect line. To be counted as a “hit”, a portion of the shrub must cross the transect tape’s interval number line e.g., 2’, 4’, 6’…. nth. If a portion of the shrub does not break the vertical plane at the interval number line, it is reported as a miss (Figure 5). Either a “hit” or “miss” is recorded on data loggers and/or paper data sheets for each designated interval.

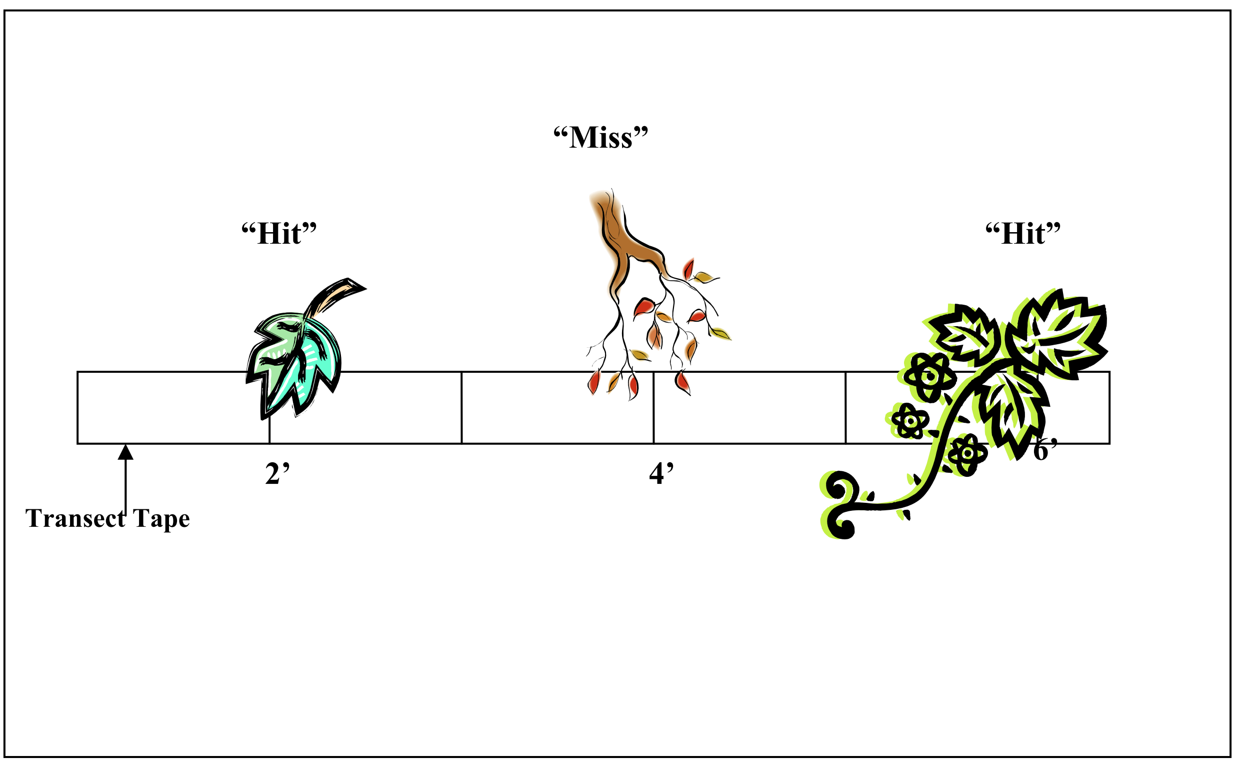


Figure 5. Point intercept method example showing “hits” and “misses” at two foot intervals.

From 5% to 20% cover, point data is collected at two-foot intervals (50 possible "hits" per 100 ft. sample unit). If shrub cover is estimated at >20%, shrub point data is collected at five foot intervals (20 possible "hits" per 100 ft. sample unit). On rare occasions, ten-foot intervals may be used when shrub cover exceeds 50% (10 possible "hits" per 100 ft. sample unit). The ten-foot interval is generally applied to shrub monocultures, or areas with few shrub species that exhibit relatively equal shrub distribution/density.
Shrub "hits" are recorded by species. Where shrubs overlap, shrub intercept is recorded for the tallest shrub and noted for the lower shrub(s).

4B-1: 2' interval
4B-2: 5' interval
4B-3: 10' interval

4C: Modified point method is used when shrub cover is impenetrable or otherwise inaccessible. A baseline transect is established along the shrub edge. A six-foot measuring rod is then inserted into the shrub cover at right angles to the baseline tape at appropriate intervals. Recorders estimate shrub "hits", species information, and height data where the end of the six-foot measuring rod intercepts the shrub cover (Figure 6). As with point intercept, intervals may very. Shrubs are identified by species.

4C-1: 2' interval
4C-2: 5' interval
4C-3: 10' interval

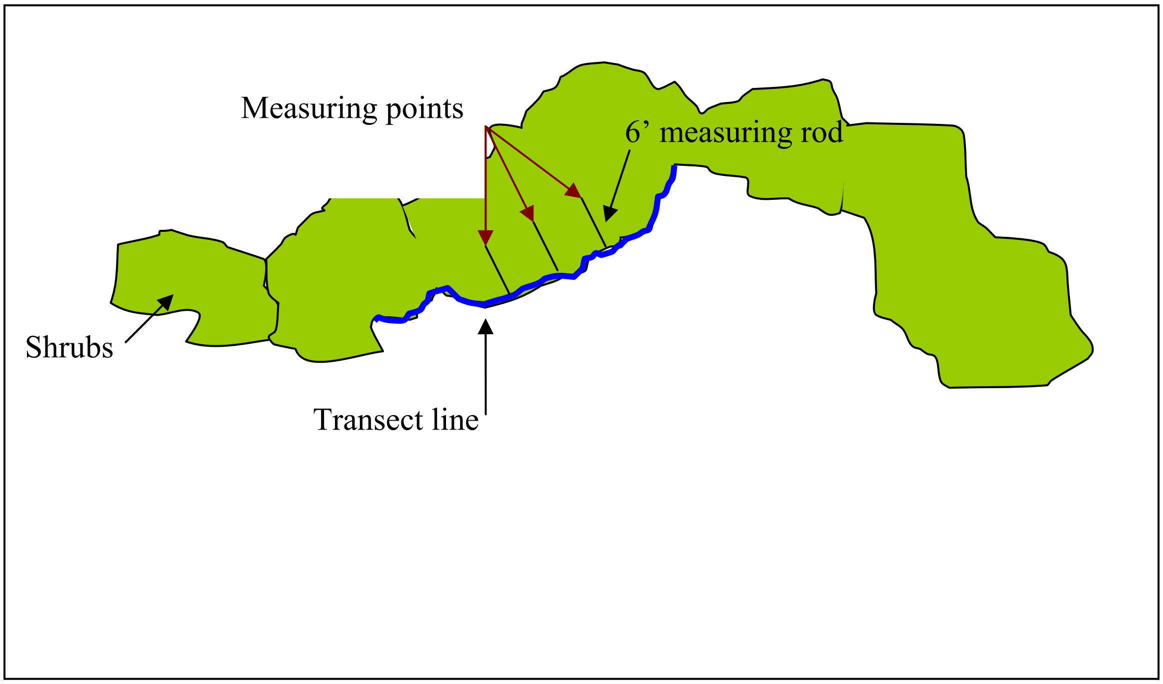


Figure 6. Modified point intercept layout example.

4D: Complex shrub intercept is used to determine percent shrub cover in multi strata shrub communities. This method is generally associated with point intercept methods whereas overlapping shrubs are identified for each stratum. Percent cover is determined for each of four possible strata as well as total percent shrub cover and overlapping percent cover.

The complex shrub intercept method is identified by adding the suffix "4D" after the appropriate line or point intercept method. For example, "4B-1-4D designates that complex shrub point intercept measurements were taken at two foot intervals. Similarly, 4C-2-4D designates that modified point intercept at five foot intervals was used to determine percent shrub cover for strata in a complex shrub community.

Shrub Height

5. Shrubs are defined as woody vegetation including trees <16 feet in height unless otherwise defined in HEP models. The Regional HEP Team assumes that trees <16 feet tall function ecologically more like shrubs than trees.

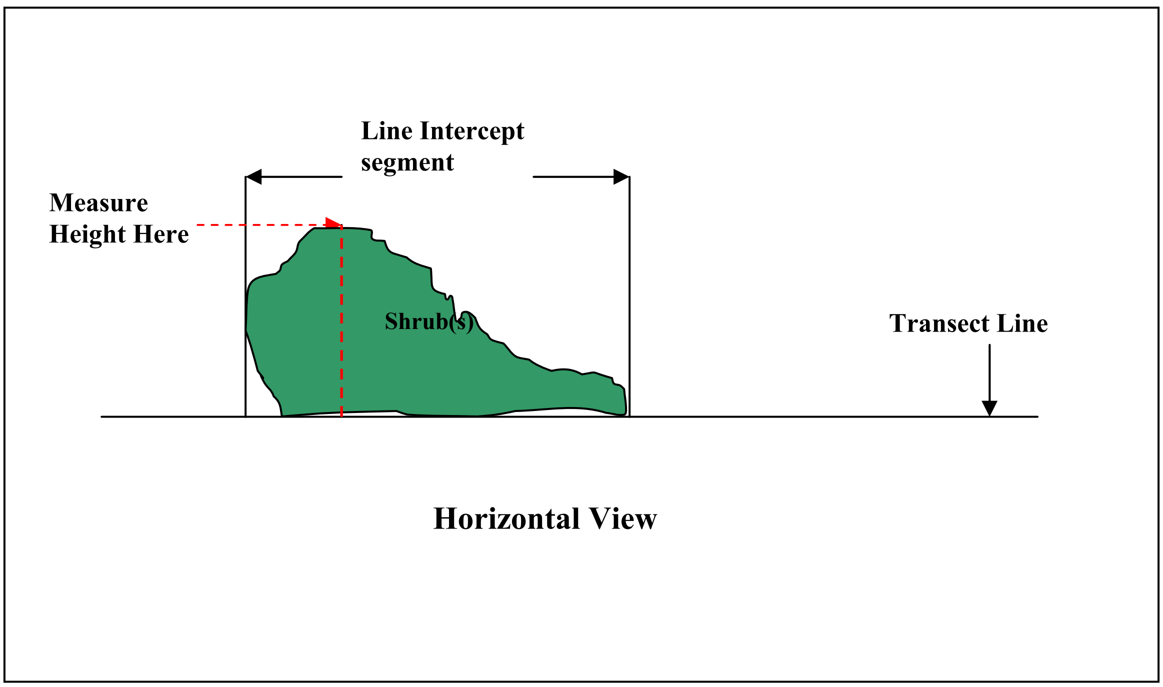


Figure 7. Line intercept shrub height measurement example.

Shrub height is measured in 10^{ths} of feet at the highest point for each uninterrupted line intercept segment as depicted in Figure 7, or the highest point that crosses each point intercept interval mark on the transect tape (Figure 8).
In structurally complex (overlapping) shrub communities, height is measured for each stratum (maximum of four) as illustrated in Figure 9. It is assumed that shrub height measurements correspond to the method used to determine percent shrub cover. For example, if percent shrub cover is determined using the line intercept

method (Figure 4), then it is assumed that shrub height will be obtained as illustrated in Figure 7.

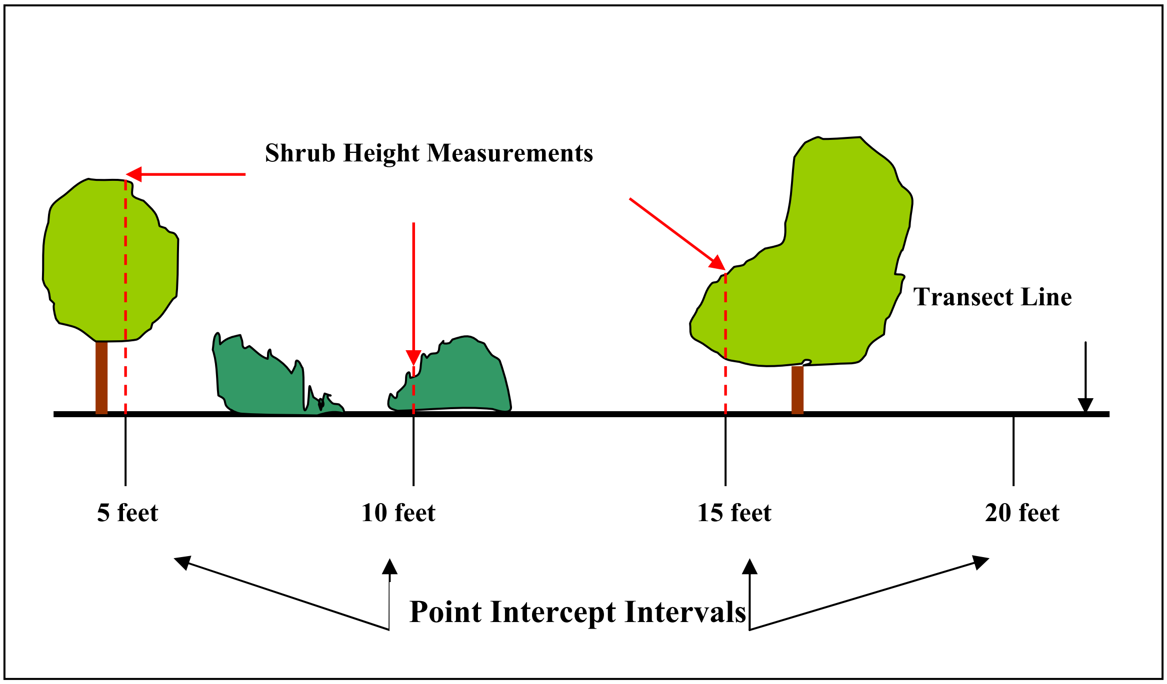


Figure 8. Point intercept shrub height example.

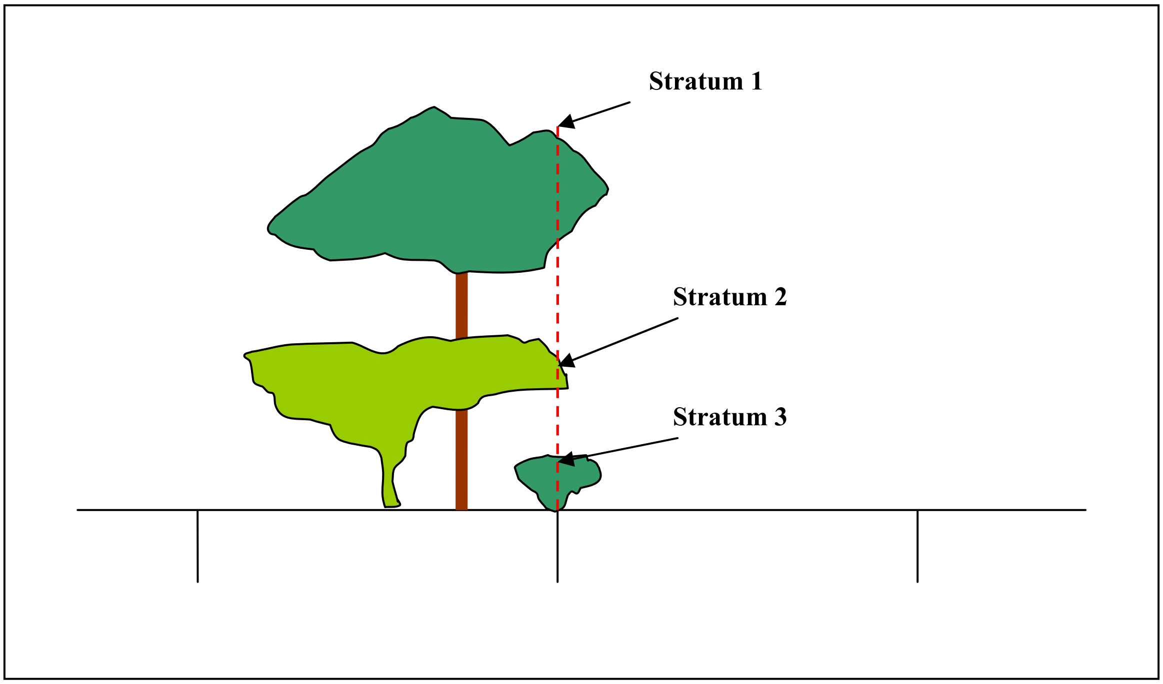


Figure 9. Complex shrub community shrub height measurement example.

Tree Measurements

Percent Canopy Cover

6. Tree canopy cover measurements are recorded at five or ten foot intervals with a densitometer (point intercept). Measurement intervals are determined by visually estimating tree canopy closure prior to initiating the survey. If estimated canopy closure is < 20% and estimated transect length ≤ 900 feet, measurements are recorded at five-foot intervals; if estimated canopy closure is > 20% and estimated transect length is ≥ 600 feet, ten-foot intervals are used. The size of the sample area strongly influences transect length. In small areas, data from several short (300 foot) transects may be "pooled" in order to determine percent tree canopy cover. As with shrubs, sampled trees are identified by species and the sampling unit is a 100 foot segment of the transect.

    6A: 5' interval
    6B: 10' interval

Height

7. Tree height is determined generally using a clinometer. In open areas, an electronic height measurement instrument may be used. Measurements are taken at the beginning and end of each transect and at 100 foot intervals. Additional samples may be taken if needed. HEP model variable requirements determine the extent of tree height measurements e.g., multi-canopy, overstory, etc.

Basal Area

8. Tree basal area data is collected at 100-foot intervals using a "factor 10" prism. Each 100-foot interval basal area observation (all tree "hits" at each 100-foot point) is considered an independent sample.

Snag DBH

9. Snag data is collected on belt transects. RHT members collect snag data in conjunction with tree canopy closure measurements using the same baseline transect. The diameter breast height (DBH) of all snags present within tenth-acre belt transects paralleling the baseline transect is measured. Either the actual DBH is recorded, or snag data is reported by class e.g., 5 snags <4" DBH, 2 snags >20" DBH etc.

Belt transects are 44 feet wide by 100 feet long i.e., 22 feet on each side of the baseline transect. Belt transect layout is depicted in Figure 10. As with shrubs and trees, the sampling unit is each 100-foot segment.

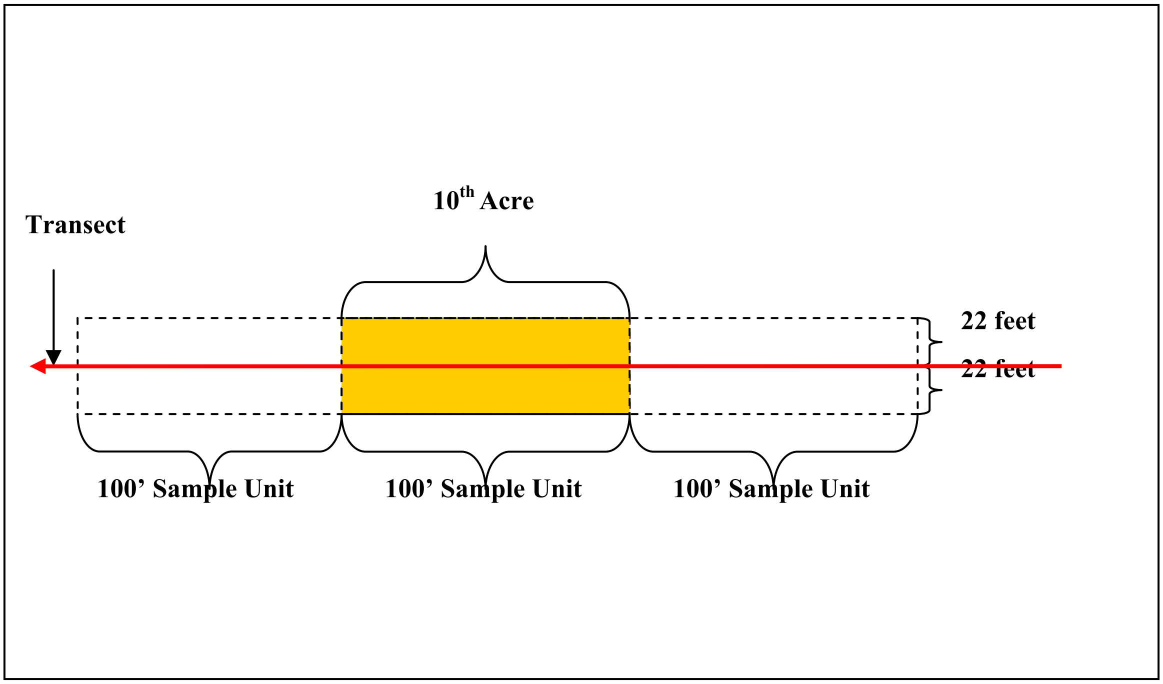


Figure 10. Belt transect layout diagram.

Sample Size Determination

The process for determining sample size (transect length) varies based on the variable measured. Shrub and tree cover and grid sample sizes are estimated as follows:

> The amount of cover within each 100 foot sample unit is divided by sample unit length to obtain percent shrub/tree cover per sample unit (e.g. 10 feet of cover/100 feet = 10% shrub cover). The standard deviation for each transect is calculated for percent cover data from transect sample units. Sample size (transect length) is then determined through use of the following equation (Avery 1994):
>
> $$n = \frac{t^2 s^2}{E^2}$$
>
> Where: t = t value at the 95 percent (0.05) confidence interval for the appropriate degrees of freedom (df); s = standard deviation; and E = desired level of precision, or bounds (± 10 percent). Confidence intervals may vary from 80 percent (0.20) to 95 percent (0.05) depending on habitat variable heterogeneity and project management needs. The same method is used to determine sample size for micro plot samples based on total percent cover for herbaceous species.

References

Avery, T.E., H. E. Burkhart. 1994. Forest measurements. 4th edition. John Wiley and Sons. New York, NY.

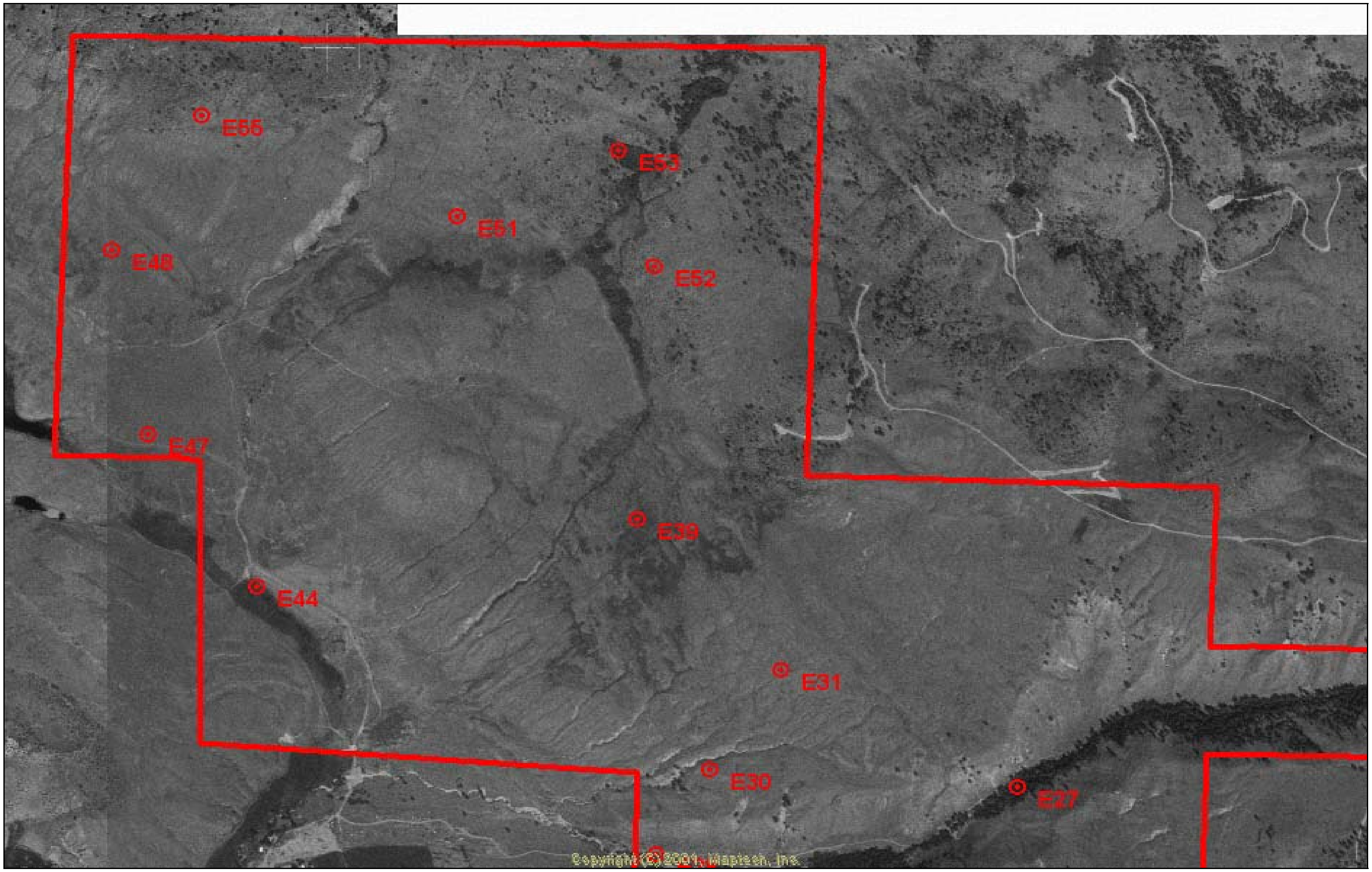
BLM. 1998. Measuring and monitoring plant populations. BLM Technical Reference 1730-1. BLM National Business Center. Denver, CO. 477 p.

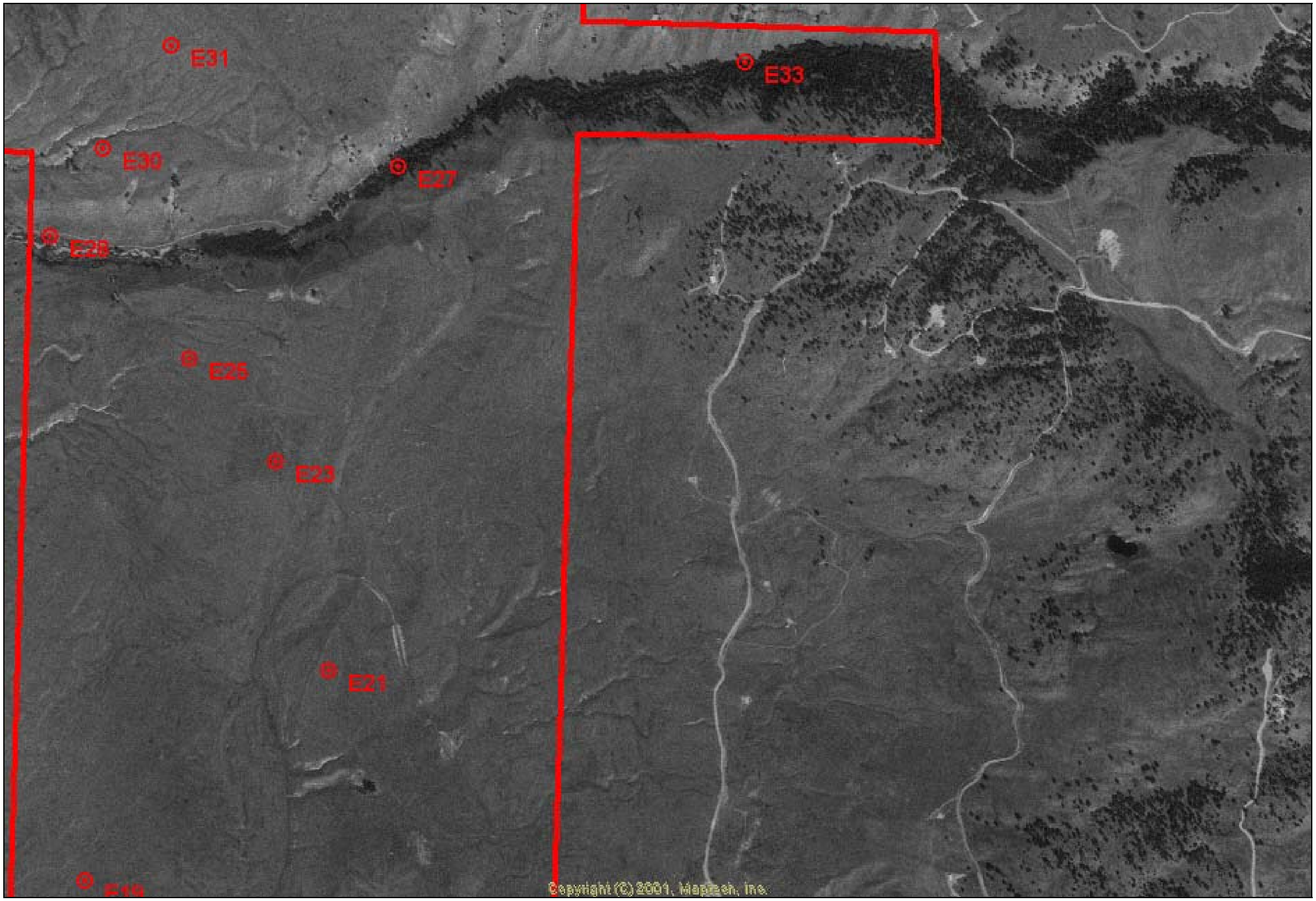
Block, W.M., W.L. Kendall, M.L. Morrison, and M. Dale Strickland. 2001. Wildlife study design. Springer Press. New York, NY. 210 p.

Hays, R. L., C. Summers, and W. Seitz. 1981. Estimating habitat variables. Western Energy and land Use Team. Fort Collins, CO: U.S. Fish and Wildlife Service.

Robel, R.J., J. N. Dayton, A.D. Hulbert. 1975. Relationship between visual obstruction measurements and weight of grassland vegetation. Journal of Range Management. 23: 295.

Appendix C – Transect Start Point Locations

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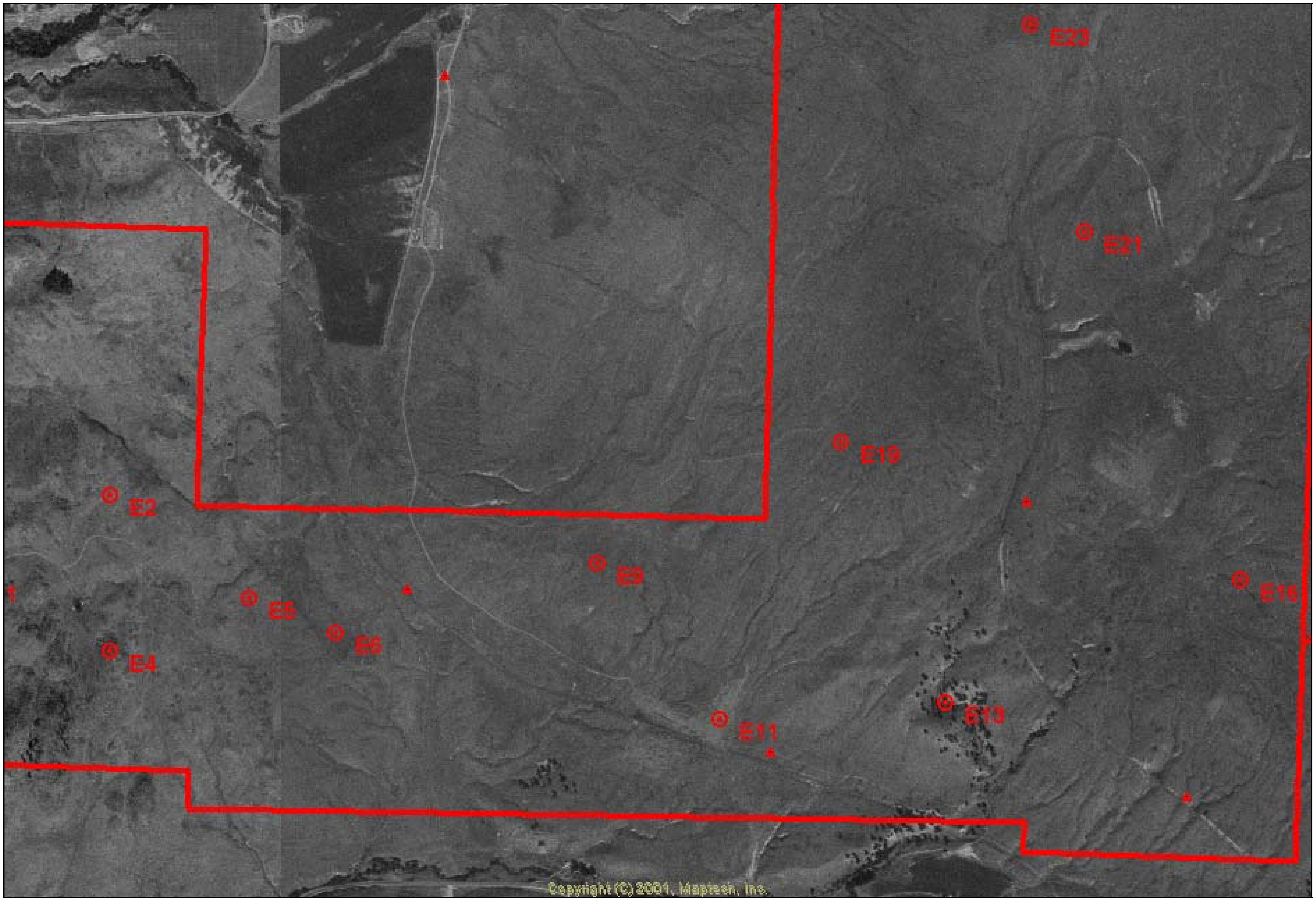
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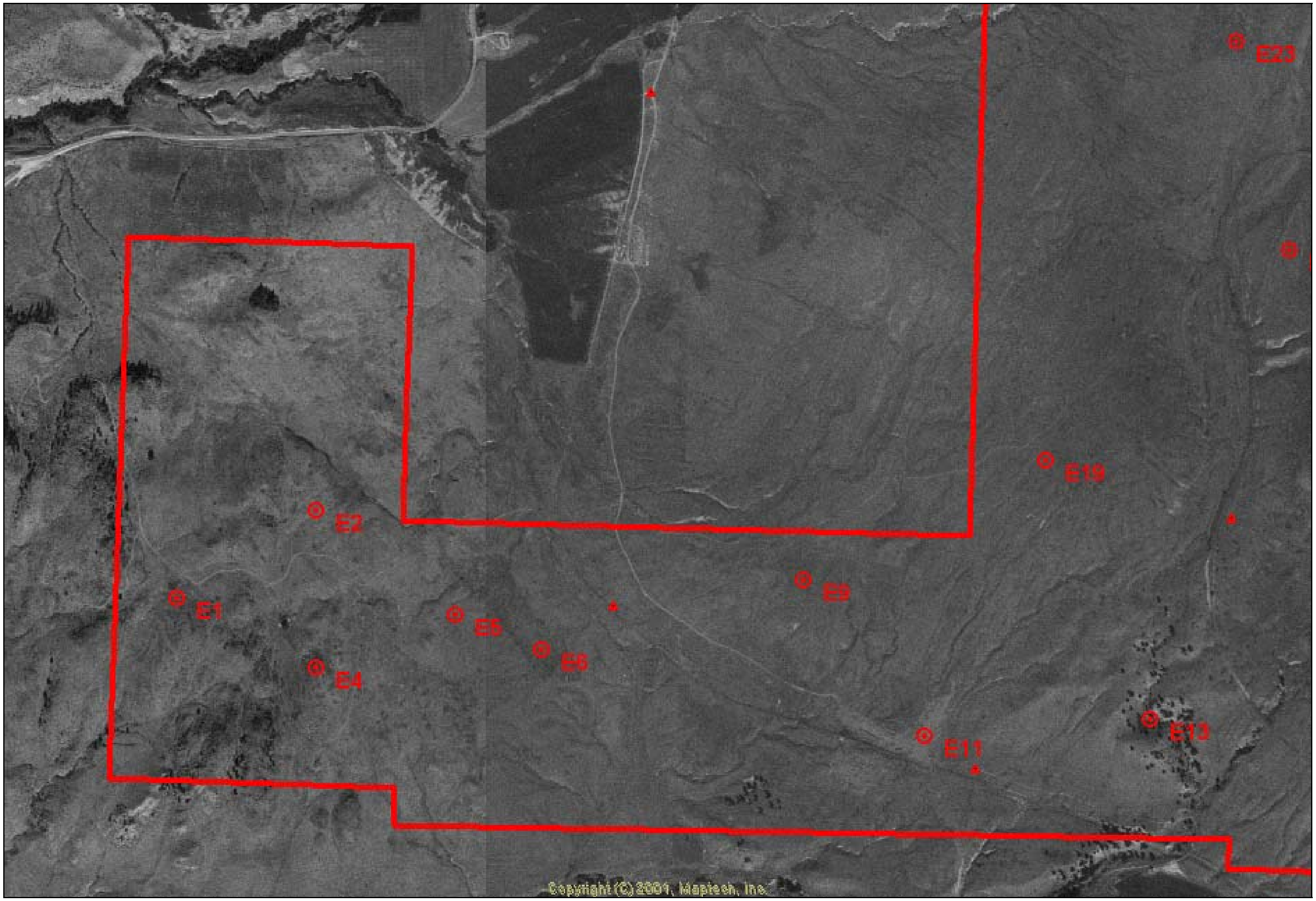
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Appendix D – Transect Photographs

Transect 1

Transect 2

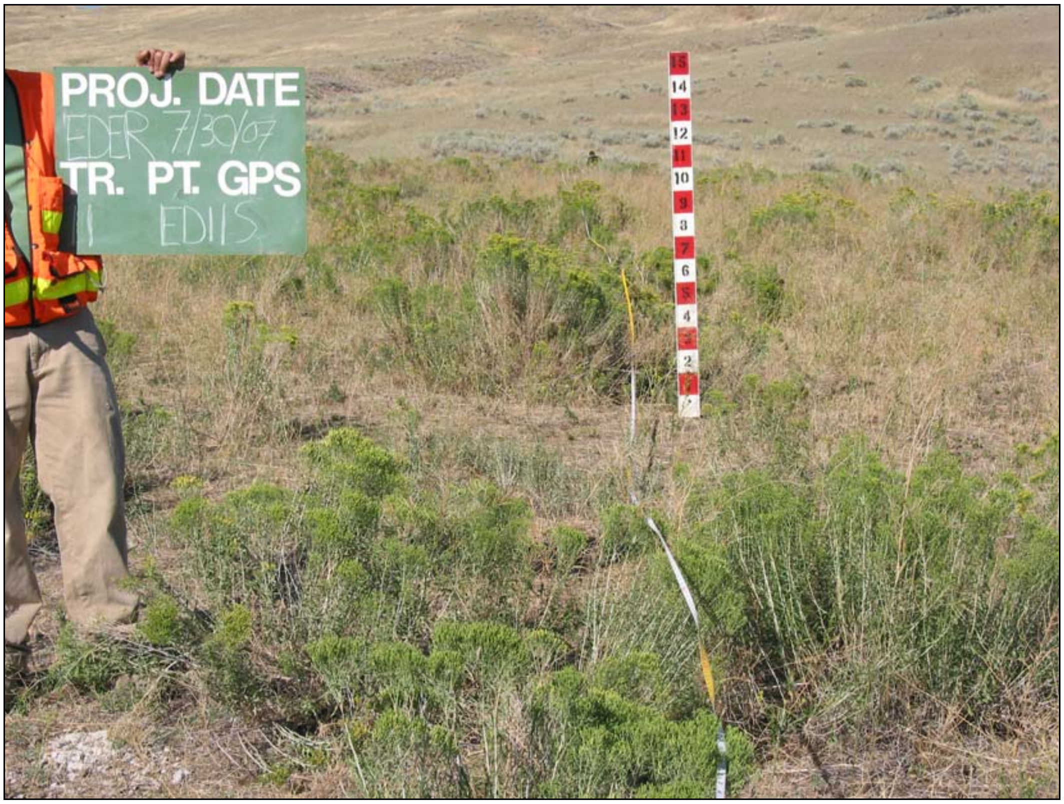
Transect 4

Transect 5

Transect 6

Transect 9

Transect 11



Transect 13

Transect 16

Transect 19

Transect 21

Transect 23

Transect 25

Transect 27
No Photograph

Transect 28
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Transect 30


Transect 31

Transect 33

No Photograph

Transect 39

Transect 44

Transect 48

Transect 51

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Transect 53

Transect 55

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Transect 69